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# PROCEEDINGS

OF THE

GENERAL MEETINGS FOR SCIENTIFIC BUSINESS

OF THE

ZOOLOGICAL SOCIETY

OF LONDON.

1909, pp. 545-952.

(MAY—DECEMBER.)

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PRINTED FOR THE SOCIETY,  
AND SOLD AT THEIR HOUSE IN HANOVER SQUARE,

LONDON:

MESSRS. LONGMANS, GREEN, AND CO.,  
PATERNOSTER ROW.

BRITISH MUSEUM  
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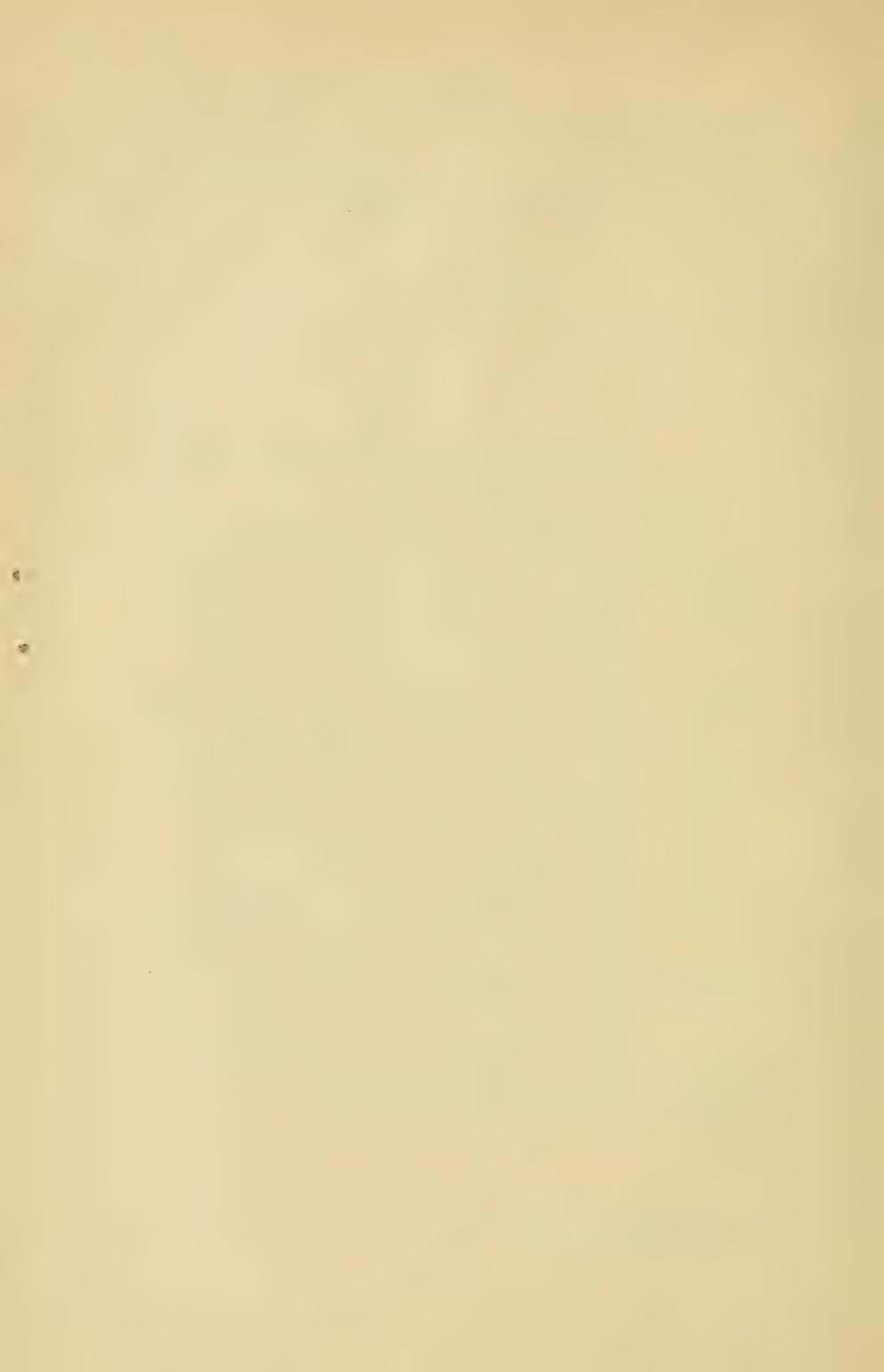
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P. Z. S. 1909 :—

Page 564, line 2 from bottom, *for* 'Science Progress'  
*read* 'Knowledge,' vol. xxv. p. 220.

Page 601, line 23 from top, *for leoninina* read *leonina*.

PROCEEDINGS  
OF THE  
GENERAL MEETINGS FOR SCIENTIFIC BUSINESS  
OF THE  
ZOOLOGICAL SOCIETY  
OF LONDON.  
1909.

Pages 545-738.

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PART III. CONTAINING PAPERS READ IN  
MAY AND JUNE.

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OCTOBER 1909.

PRINTED FOR THE SOCIETY,  
SOLD AT THEIR HOUSE IN HANOVER SQUARE.

LONDON:  
MESSRS. LONGMANS, GREEN, AND CO.,  
PATERNOSTER ROW.

[*Price Twelve Shillings.*]

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(May to December, 1909.)

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May 11, 1909.

Prof. E. A. MINCHIN, M.A., Vice-President,  
in the Chair.

Mr. R. H. Burne, M.A., F.Z.S., exhibited a series of specimens, from the Museum of the Royal College of Surgeons, of adaptive structures for the respiration of air in some Aquatic Invertebrates and tropical Freshwater Fishes.

---

Mr. R. I. Pocock, F.L.S., F.Z.S., the Superintendent of the Gardens, exhibited the skin of a Monkey, representing a well-marked undescribed local race of *Cercopithecus tantalus*, which he proposed to name *Cercopithecus tantalus alexandri* in honour of Capt. Boyd Alexander, F.Z.S., who had brought the specimen from Lake Chad and presented it to the Society. He said:—  
“The colour of the upper side of this specimen is speckled greyish green, the coloured annuli in the hairs being less green than is usually the case in Nigerian examples of *C. tantalus*, but as in the latter it becomes richer on the crown of the head; the face is wholly black and the white brow-band is well marked. The whiskers, however, are very long, as in *C. aethiops* of Abyssinia and the Upper Nile; but instead of being wholly white, as in

that species, the hairs are slightly stained with yellow and very indistinctly speckled apically. Owing to the whiteness of the whiskers the brow-band is not so sharply defined at its extremities as in typical *C. tantalus*, where the whiskers are not only much shorter but are markedly stained with yellow almost throughout their length. The hairs of the sides of the neck are also long and mostly white, but towards the apex yellowish and speckled with black. On the arm and leg the greenish tint dies out of the hairs well above the elbow and knee, and it only extends for a short distance upon the root of the tail; the rest of the arms and legs, the hands and feet, and the upper side of the tail being grey. As in typical *C. tantalus*, the inner sides of the limbs, the under side of the body and of the tail are white, with a patch of rusty hairs upon the pubic region; and, as in *C. tantalus tantalus* and *C. aethiops*, there is a conspicuous tuft of whitish hair on each side at the base of the tail above the ischial callosity.

"Although the length and whiteness of the whiskers give this monkey a striking superficial resemblance to *C. aethiops*, it appears, as might be expected from its locality, to be most nearly allied to *C. tantalus*, being at once distinguishable from *C. aethiops* by the absence of white hairs from the lips and chin. Nevertheless, it is in a measure intermediate between the two species, and to a great extent justifies my surmise (P. Z. S. 1907, p. 733) that the two will be found to intergrade.

"*C. tantalus* is now known to be represented by three races; namely, the typical *C. tantalus tantalus* from Nigeria, *C. tantalus alexandri* from Lake Chad, and *C. tantalus budgetti*\* from Bathyaba on the eastern shore of Lake Albert in Uganda. The last-mentioned differs from the others in having the whiskers much more decidedly speckled, and in the large size of the red patch and the more fiery colour of its hairs on the pubic area."

---

Mr. W. F. H. Rosenberg, F.Z.S., exhibited a Rook in which the upper mandible had overgrown the lower to a remarkable extent. This abnormality had evidently been caused by an injury to the tip of the lower mandible having deprived the upper one of the opposing surface necessary to check its growth.

The bird was shot by Mr. Percy I. Lathy, F.Z.S., F.E.S., on February 7th, 1909, at Nazeing, Essex. Mr. Lathy shot it out of a flock, and did not notice anything peculiar till he picked the bird up. The bird was in good condition, so that it could not have had the difficulty in feeding which one might have expected from the excessive prolongation of the upper mandible.

Length of upper mandible 70 mm.; length of lower mandible 51 mm. Normal length of upper mandible 55 mm.

---

\* Pocock, P. Z. S. 1907, p. 733.

The following papers were read :—

1. Contributions to the Study of the Equidæ ; i. The Differentiation of the Three Species of Zebras. By Prof. WILLIAM RIDGEWAY, M.A., Sc.D., F.B.A., LL.D., Litt.D.\*

[Received April 21, 1909.]

(Text-figures 140-155.)

I propose to describe ten skins of Zebras from British East Africa, the interest of which consists partly in the fact that they were all shot expressly for me, and that an exact record of the locality and the altitude was kept in each case. They have thus a far higher scientific value than the ordinary specimens in our museums, which have for the most part been obtained from sportsmen or traders, who could give no accurate information regarding the provenance of the specimens. I must express my gratitude to the Rt. Hon. Alfred Lyttelton, K.C., M.P., who when Secretary of State for the Colonies authorised the officials of British East Africa to assist me in obtaining zebra skins, and to my friend, Mr. C. W. Hobley, C.M.G., Assistant-Commissioner at Nairobi, who kindly undertook to see that the instructions of the Secretary of State were carried out, and on whom devolved all the trouble of packing and despatching the specimens.

But the skins have a further value, since they demonstrate that the individuals of the same species vary in coloration from locality to locality, and that it is useless attempting to make species or subspecies out of animals which are mere local varieties. Finally, we may reason from what these skins demonstrate as taking place in a given area that the same differentiation has taken place in the coloration of all the Equidæ from Northern Europe and Asia down to Cape Colony, a lesson which applies equally to the whole animal kingdom, man included.

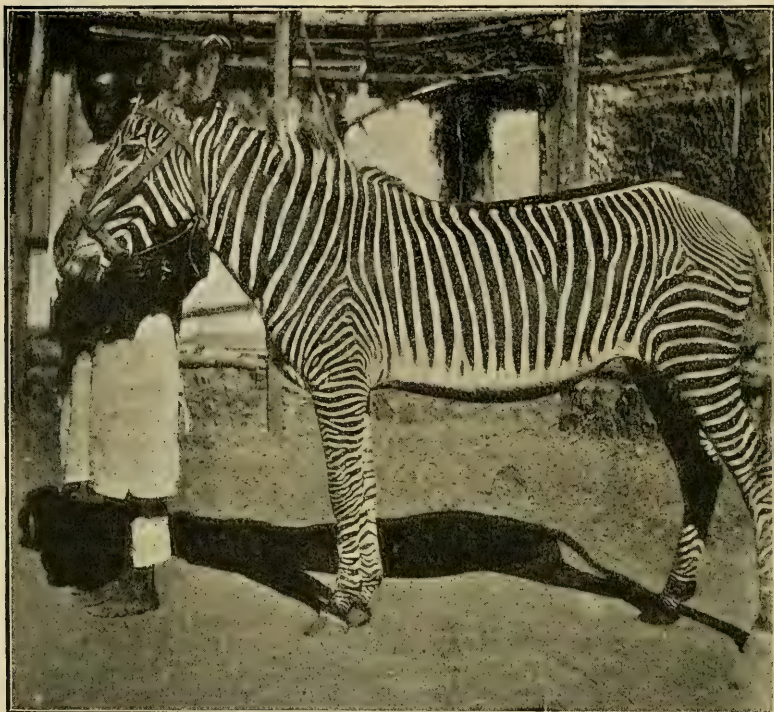
Zoologists are generally agreed that all existing Zebras fall into three main species:—*Equus zebra*, or the Mountain Zebra, formerly very abundant in Cape Colony, *E. burchelli*, and *E. grevyi*, though Dr. Matschie treats as true species certain varieties of the Burchell family. Mr. Pocock has shown that all the varieties of the Burchell Zebra seem to shade off into the better marked specimens of the now extinct Quagga of Cape Colony, whilst Prof. Ewart has shown that a bridge can be found between the Mountain Zebra and the Burchelline family, through Crawshaw's variety of the latter.

The chief characteristics of the three species may be briefly enumerated.

The splendid Grévy Zebra, found in Somaliland, Shoa, and

\* Communicated by Dr. P. CHALMEERS MITCHELL, M.A., F.R.S., F.Z.S.

Text-fig. 140.

Grévy Zebra (*E. grévyi*).

Text-fig. 141.

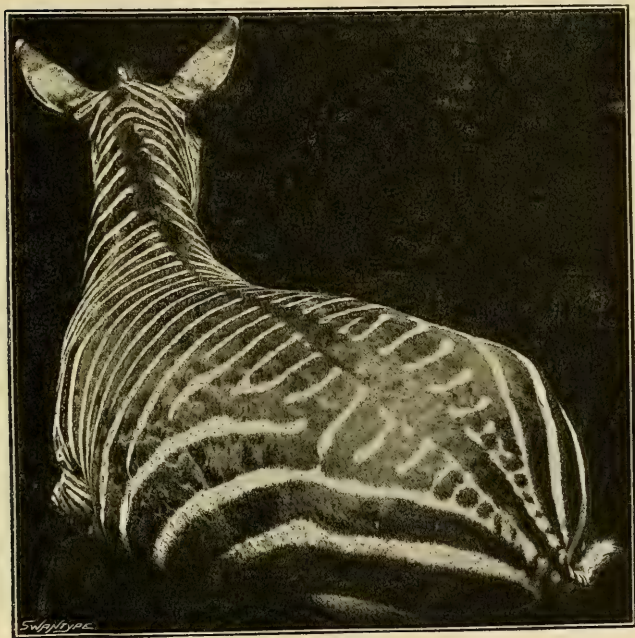
The Mountain Zebra (*E. zebra*).



British East Africa as far south as the River Tana, is covered with narrow stripes (text-fig. 140), and its ears are more ass-like than those of the other two species, though its feet are more like those of the horse. In many specimens there are small stripes coming out from the dorsal stripe over the croup, but there are distinct variations in coloration between the Somali, Shoa, and British East Africa specimens.

The Mountain Zebra (text-fig. 141) is also striped all over its body and legs, but the stripes on the haunches differ completely from those of the Grévy species, whilst a chief characteristic is the small stripes on its croup termed its "gridiron."

Text-fig. 142.



Ward's Zebra (Baringo).

In a skin procured from Mr. Rowland Ward, Prof. Ewart found an animal almost the same as the South African Mountain Zebra, which he named Ward's Zebra. There is some doubt as regards the provenance of this skin. It first appeared to have come from Somaliland, but I embodied in my 'Origin and Influence of the Thoroughbred Horse' (p. 508) a note from Prof. Ewart stating that it came from the Lombori Hills, which form the southern edge of the Naivasha Plateau near the Uganda Railway in British East Africa. Of its provenance I will say more later on.

My illustration (text-fig. 142, p. 549), by the kind permission of Messrs. Rowland Ward & Co. and of Mr. R. Lydekker, F.R.S., is from the latter's 'The Game Animals of Africa,' fig. 23, p. 65.

In the Burchelline group the enlargement of the stripes seen on the haunches of the Mountain Zebra is found all over the body. The stripes are far larger and fewer in number, whilst in many varieties shadow stripes are seen, the vestiges of the closer striping still surviving in the Grévy and Mountain species.

Text-fig. 143.

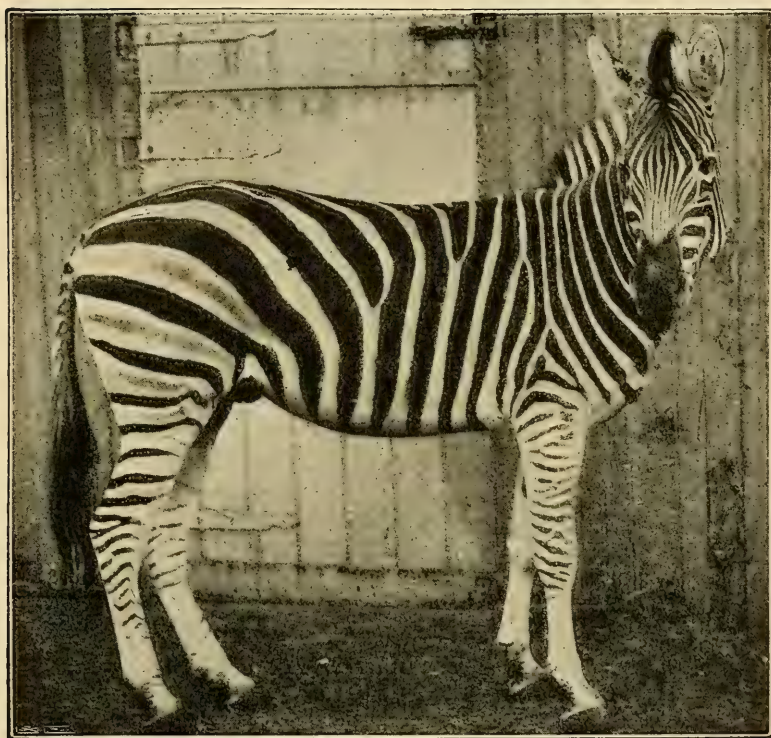


*E. burchelli* (var. *granti*).

The most northerly variety of this species is Grant's Zebra (text-fig. 143) found all over East Equatorial Africa. As we advance southwards we find it shading off into Chapman's variety found in the Transvaal, in which the legs are no longer striped down to the hoof (text-fig. 144), whilst in the typical Burchell Zebra or Bonte Quagga of the Orange River Colony the legs and the under surface of the body are free from stripes (text-fig. 145, p. 552).

The Crawshay variety of the Burchell Zebra found in Nyassaland, so far as colour is concerned, as Prof. Ewart has pointed out, is the bridge between the Burchell and Mountain Zebras, as it has black stripes close together, and small stripes on the croup, resembling the "gridiron" of the Mountain Zebra and recalling the small stripes in some Grévy Zebras.

Text-fig. 144.



*E. burchelli* (Chapman's variety).

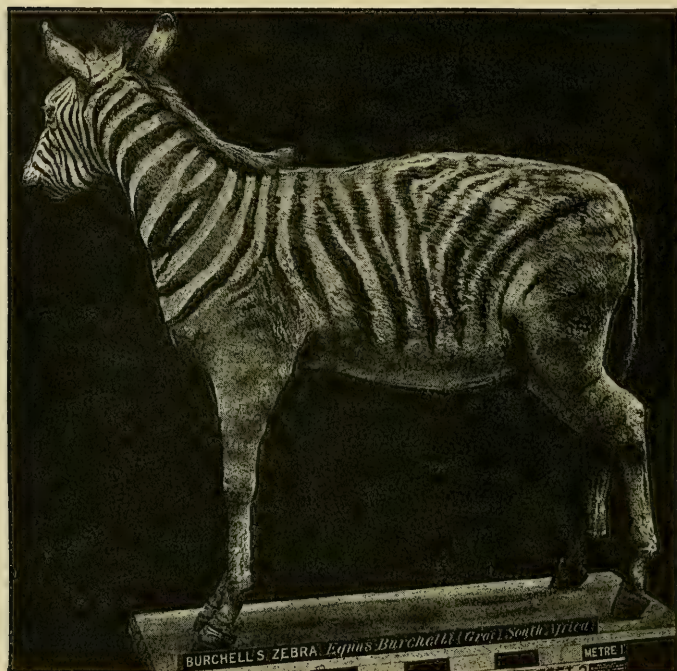
It is now universally held that in the Grévy Zebra we have the oldest type of coloration of the Zebra family, though I have argued elsewhere against the doctrine formerly held that in its skin we have the primæval livery of the ancestor of all the Equidæ. In coloration at least the other two species are more recent than the Grévy.

I here figure ten skins, two of Grévy's Zebra, and eight of Grant's variety of *E. burchelli*. Text-figs. 146 & 147 show the



skins of a male and a female Grévy Zebra shot by the late Mr. A. H. Neumann at Euaso Nyiro at an altitude of 3000 ft. Both specimens lack the small stripes commonly found in specimens from Somaliland and Shoa, and which correspond to the "gridiron" of the Mountain Zebra. Text-figs. 148 & 149 show the skins of a male and a female of Grant's variety from Baringo (3000 ft.). The former shows faint, the latter more marked vestiges of the croup or "gridiron" stripes, thus showing a slight approximation in colouring to the Grévy and Mountain Zebras.

Text-fig. 145.



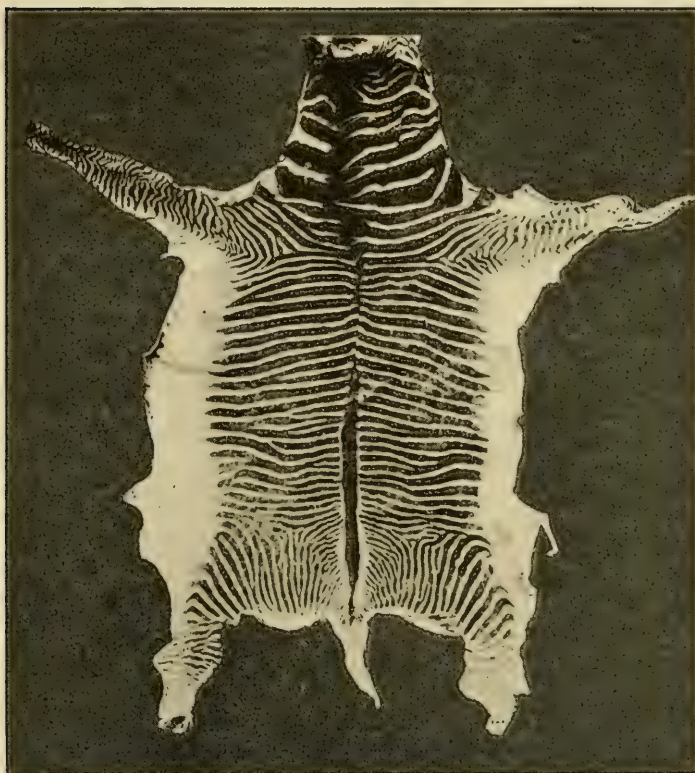
*E. burchelli* (Bristol).

Text-figs. 150 & 151 exhibit two skins (male) from Laikipia (5800 ft.). Text-figs. 152 & 153 give the skins of a male and a female from Uasingishu (6500 ft.). Next comes that of a male from Kinolop (7500 ft.), whilst text-fig. 155 is that of a male from the north end of the Aberdare Range (8000 ft.). The last has longer hair than the rest. The variation in the skins from different localities and altitudes is obvious. This is in accord with the testimony of that excellent observer, Mr. A. H. Neumann, who ('Elephant-hunting in East Equatorial Africa,' p. 372)



notes in reference to a zebra shot in one locality that "along its back were spots or blotches instead of distinct stripes," and he remarks that there are many local varieties of the same species. He told me also that in the area just referred to, all the Grant's Zebras he met had this blotching on the back. In this respect they seem to resemble my two skins from Baringo.

Text-fig. 146.

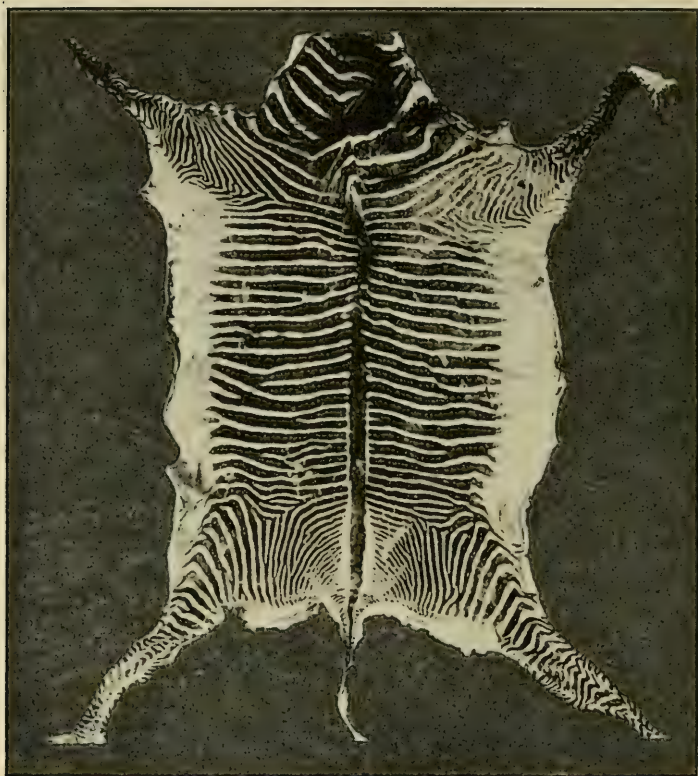


Grévy Zebra (male); Euaso Nyiro (3000 ft.).

Can we discover the region where the differentiation of all three species gradually took place? It ought to be where all three species once overlapped or still overlap. This would rule out South Africa, for no animal of the Grévy type has ever been found in those latitudes. But in the northern part of British East Africa in the region round Lake Rudolph and Lake Baringo the Grévy and Burchelline Zebras are found overlapping as far south as the Tana

River, below which the Grévy species, as is stated by Mr. A. H. Neumann, does not occur. On the other hand the Burchell type is never found in Somaliland or Shoa, where the Grévy species seems to be the sole zebra, and where its nearest neighbours are the Somali and the Abyssinian Asses. It thus extends further up than the other zebras in North-east Africa. But in the region round

Text-fig. 147.



Grévy Zebra (female) ; Euaso Nyiro (3000 ft.).

Lake Baringo where the Grévy Zebra overlaps the Burchelline, at least one specimen of the latter is known to possess a functional premolar, a feature common in Grévy Zebras, and a peculiarity which is a survival from Pliocene forms such as *E. sivalensis* of India and *E. stenonis* of North Africa and Southern Europe.

Two of my skins (text-figs. 148 & 149), both from animals shot at Lake Baringo, have small stripes or spots indicating vestiges

of such small stripes as those found on the croup of Crawshay's Zebra from Nyassaland, and which resemble the small stripes on the croup of many Grévy Zebras and the "gridiron" of the Mountain Zebra.

Text-fig. 148.



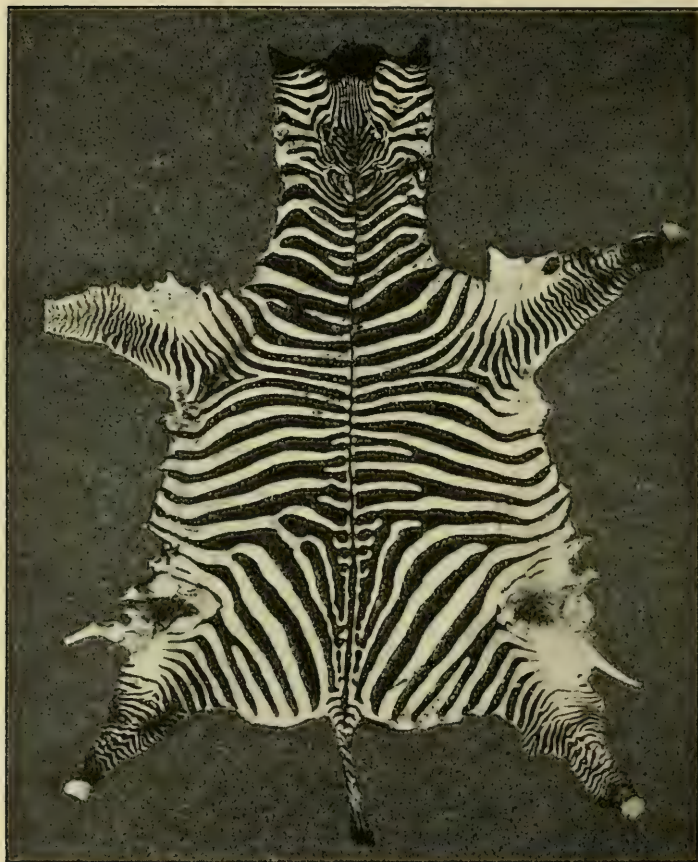
Grant's Zebra (male); Baringo (3000 ft.).

Thus at Lake Baringo we have a point of contact between the Grévy and the Burchelline Zebras, not only in coloration but in osteology. Now if we could find a zebra of the Mountain type in that same area we might not unreasonably infer that in this region we have the point from which the various species of zebras had radiated.



I have not been as yet able to get a specimen of Ward's Zebra from this area. But, on the other hand, Mr. C. W. Hobley not long since wrote to me the substance of a conversation which he had with Lord Delamere, the well-known big-game shooter. The latter told Mr. Hobley that he had sent home to Mr. Rowland

Text-fig. 149.



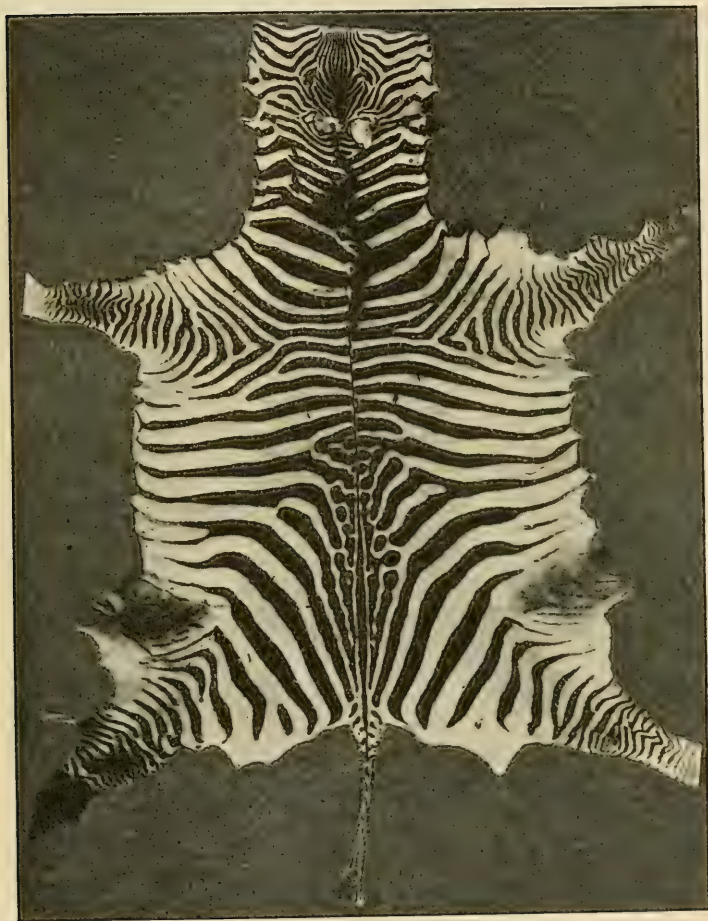
Grant's Zebra (female); Baringo (3000 ft.).

Ward the skin of a zebra, which some one had named after Mr. Ward. This animal Lord Delamere said he had shot at Baringo. We have thus at last got the true provenance of this very important specimen from the mouth of the sportsman who shot it.



But as Ward's Zebra is virtually the Mountain Zebra only locally varied, I submit that it was in the northern part of British East Africa that the differentiation of the three species, not only in colour, but also in osteology, had begun.

Text-fig. 150.



Grant's Zebra (male) ; Laikipia (5800 ft.).

In this area there are lofty mountains, elevated plateaus and low-lying swamps, as well as hill country with abundance of grassy patches in it. Is it to these different types of country that the differentiation in types may be due?

I had remarked in reading Mr. A. H. Neumann's excellent book, 'Elephant-hunting in Equatorial East Africa,' that although both Grévy and Burchelline Zebras are found in the same country and not unfrequently together, yet on the whole

Text-fig. 151.

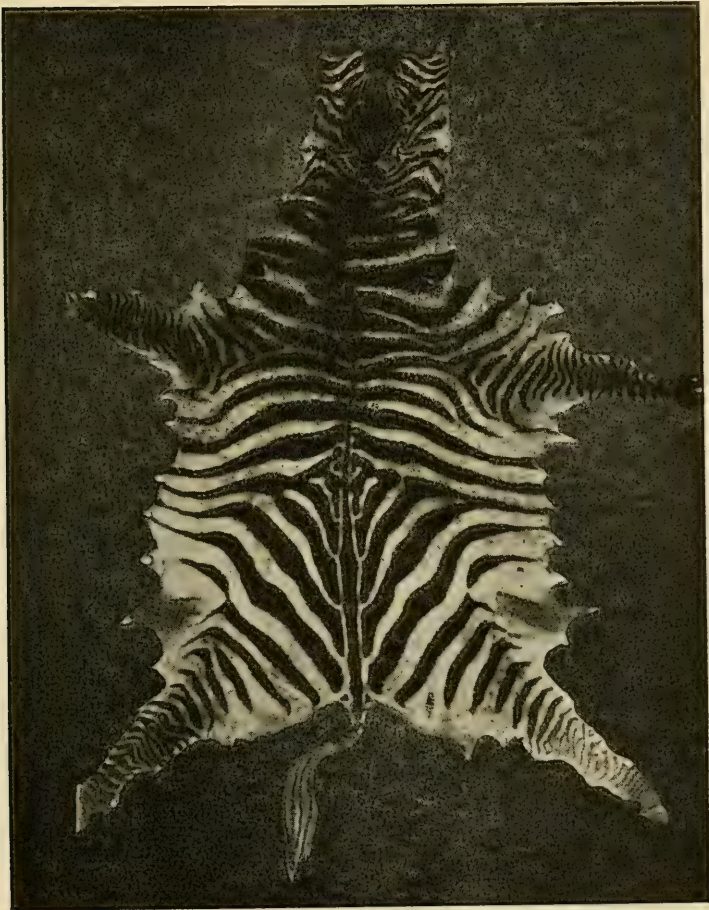


Grant's Zebra (male); Laikipia (5800 ft.).

Grévy Zebras live in low-lying grounds with a thin vegetation of prickly shrubs, whilst the Burchelline species lives commonly at a higher elevation and where there is more bush and richer pasture. But on the mountains and plateaus of this area the conditions

are much the same as in the mountainous regions of South Africa, where the Mountain Zebra was formerly abundant.

Text-fig. 152.



Grant's Zebra (male) ; Uasingishu (6500 ft.).

I had an opportunity of talking over this view with Mr. Neumann, who approved of it, and in confirmation told me that he had visited the great swamp at the upper end of the Euaso Nyiro River, and in the low-lying lands there, although it was within the geographical area occupied by the Burchelline Zebras (Grant's variety), he never found any of that species,



though the Grévy Zebras were abundant. I had previously noted in Col. Swayne's valuable paper (P. Z. S. 1894) that in Somaliland the Grévy Zebra lives in a like environment. He found them first at Durhi, about 300 miles inland from Berbera. These zebras are very common in the land of the Rer Amaden and

Text-fig. 153.



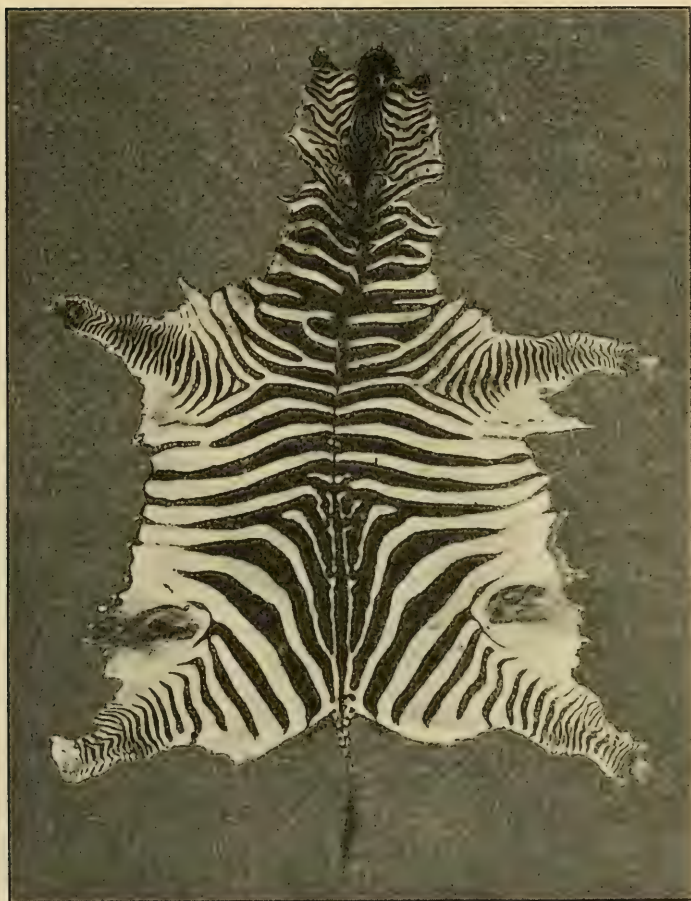
Grant's Zebra (female); Uusingishu (6500 ft.).

Malingur tribes. "The country there is covered with scattered bush over its entire surface, and is stony and much broken up by ravines; the general elevation is about 2500 feet." The zebras "were met on low plateaux covered with scattered thorn bush and glades of *durr* grass, the soil being powdery and red in colour with



an occasional outcrop of rocks. I saw none in the open flats of the Webbe Valley, and they never come near so far north as the open grass plains of the Haud, Durhi south of the Fafan being their northern limit."

Text-fig. 154.



Grant's Zebra (male); Kinolop (7500 ft.).

On the high plateaus it is quite possible that Ward's Zebra, or in other words the Mountain Zebra, was differentiated. Mr. Neumann told me that he knew three or four localities where it might be quite possible to find the Mountain Zebra, and it was his intention, when he went out again, to make a diligent search for such.

That animals living at a high elevation have to adapt themselves

to it, is shown by a skin (text-fig. 155) of a Grant's Zebra shot on the Aberdare Range about 8000 feet high. The hair of this skin is much longer than that of my other skins from East Africa. Mr. Neumann had hunted over that range, and seen a

Text-fig. 155.



Grant's Zebra (male) ; north end of Aberdare Range (8000 ft.).

few Grant's Zebras there ; they did not live on the top, but only passed up and down over the edge of the plateau.

I may point out that just as the Burchelline Zebras from the most northern point where they are met keep changing from locality to locality (as is demonstrated by my skins from East

Africa) until they passed into the Quaggas of Cape Colony, so on the north the Grévy with its ass-like ears comes closer in that respect to its neighbours, the asses of Somaliland and Abyssinia, whilst its hoof resembles that of the horse more than those of the other zebras. The difference between its hoof and those of the two other species may be due to the fact that it is not a mountain animal, but always keeps rather to the low and often swampy ground.

2. Contributions to the Study of the Equidæ; ii. On Hitherto Unrecorded Specimens of *Equus quagga*. By Prof. WILLIAM RIDGEWAY, M.A., Sc.D., F.B.A., LL.D., Litt.D.\*

[Received April 21, 1909.]

(Text-figures 156-180.)

In view of the scantiness of our existing material for arriving at any conclusions respecting the now extinct *E. quagga*, which once roamed the plains of Cape Colony in vast herds, and was found in Orange River and Griqualand West, it is most important to make known any yet surviving specimens which have hitherto escaped the vigilance of zoologists. In my 'Origin and Influence of the Thoroughbred Horse' (pp. 438-9, figs. 131-3) I was enabled to publish the head and neck of a Quagga, preserved in the Elgin Museum (to which my attention had been called by my friend Dr. Duckworth) (text-fig. 172, p. 581). This specimen shows a white ground-colour in the middle of the forehead like the typical specimen described by Edwards in 1758 (text-fig. 173, p. 582).

I.—By the kindness of another friend, Mr. R. C. Punnett, F.Z.S., Fellow of Gonville and Caius College, I am now able to describe and figure for the first time an entire specimen hitherto neglected by zoologists. This specimen is preserved in the Naturgeschichtes Museum at Basel, and for the photograph from which the illustration (text-fig. 157, p. 565) is taken as well as for the description I am indebted to the great kindness of Dr. Fritz Sarasin, the Director of that Museum. The specimen (a female) was presented to the Basel Museum in 1864 by a missionary called Gysin, who resided at Silo (Shiloh), Cape Colony. The fact that in this case, as well as in that of the Elgin specimen, we have some indication of the locality where the animal was killed is of considerable importance, inasmuch as few of the other specimens as yet known have any provenance.

Dr. Sarasin writes as follows:—"The ground-colour of the centre of the forehead is not white and not lighter than the ground-colour of other parts of the face and neck. The colour of the stripes on head, neck, and back is bright chestnut ('hell kastanienbraun,' 'brun marron clair'). The colour of the non-

\* Communicated by Dr. P. CHALMERS MITCHELL, M.A., F.R.S., F.Z.S.

striped hinder parts is bright brown ('hellbraun,' 'brun clair'). There is a broad dorsal stripe of a deep maroon ('dunkel kastanienbraun') colour, bordered on each side by a small stripe of yellowish white ('gelblichweiss,' 'blanche-jaunâtre') colour. The hair of the tail is bright cream ('hell crème'). The underparts of the body are of a 'crème-blanchâtre' colour, so also are the legs, but getting darker towards the feet."

This new specimen has a peculiar interest, for it differs from all the others known, and may serve to bridge over the gulf between the Quaggas of Cape Colony and the Burchell Zebras.

Text-fig. 156.



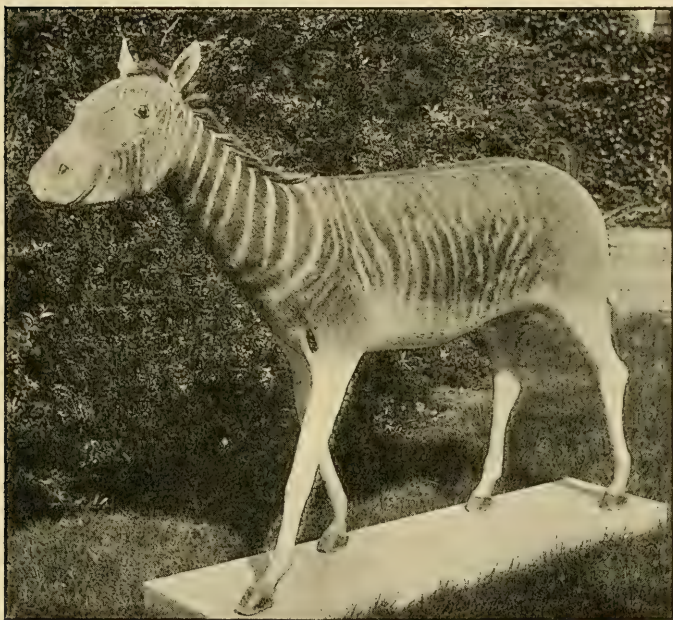
*E. burchelli* (Paris); north of Cape Colony (about 1820).

Mr. Pocock has well pointed out that the current descriptions of the Quagga are made up by blending together animals of different types, whilst he and Mr. Lydekker have suggested that the Quaggas figured by Edwards (text-fig. 173, p. 582), by Harris (text-fig. 180, p. 586), and Hamilton Smith (text-fig. 178), may be subspecifically distinct from the one photographed by York (text-fig. 164, p. 575), the last known living example of its race, which survived in the Zoological Gardens until 1872. Mr. Lydekker ('Science Progress,' 1902, pp. 220-2) proposed names for two new subspecies. (1) *E. quagga greyi*, under which fall the British



Museum (text-fig. 163), Amsterdam (text-fig. 170), Edinburgh (text-fig. 165), and Tring (text-fig. 159) specimens; the last being (he thought) that really photographed by York. (2) He applies the name *E. quagga lorenzi* to the famous Vienna specimen (text-fig. 158). But Mr. Lydekker is now very doubtful whether the division into races is justifiable, although it is possible that the Vienna specimen may be distinct, and "despite certain differences in regard to the width and backward extension of the stripes, and also the relative proportions of the white and fawn areas," he is

Text-fig. 157.



The Basel Quagga (female); Silo, Cape Colony, 1864.

"disposed to regard the quaggas figured by Edwards, Harris, and Hamilton Smith, as representing the same type of animal."

Mr. Pocock has added a third subspecies: *E. quagga danielli* (text-fig. 179, p. 585).

Mr. Pocock has argued that the Burchell Zebras and the Quaggas of Cape Colony are only subspecifically distinct, and he includes all the varieties of the Burchell Zebra as well as the true Quaggas of Cape Colony under the species *E. quagga*.

Whether these two types of animals were specifically or subspecifically distinct, the relationship between them was extremely close. Furthermore, it is generally admitted that the Vienna Quagga, of all the specimens hitherto published, comes nearest to the true Burchell Zebra.

But a glance at the illustration of the Basel Quagga will show that it comes still closer to the Burchell Zebra than the Vienna specimen, and it may be taken as virtually filling the gap which hitherto has existed between the true Burchell Zebra and the Quaggas of Cape Colony.

It would seem that we must be careful not to make species or subspecies too hastily, for it may turn out that slight local differences in the environment may cause a difference in the coloration of animals which are practically one and the same in type. This, indeed, can be put beyond all doubt by the series of skins in my own possession, which I obtained from British East Africa (*supra*, pp. 547-563).

II.—I will next describe another specimen of *E. quagga*. It has long been known by hearsay to those interested in the subject, but, so far as I am aware, it has not been described or figured by any of our leading authorities on the *Equidae*. Sad to say, it is the only specimen of the true Quagga preserved in the Museums of South Africa. For, although the Director of the Bloemfontein Museum, in reply to my inquiries, informed me that there was in the Museum a skin of the true Quagga, when the photograph, taken for me by a local photographer, arrived, the skin turned out to be probably that of the true Burchell Zebra. But as the legs had been trimmed off, it is by no means certain that it is even that of a true Burchell.

However, in the Cape Town Museum, there is a genuine relic of the true Quagga, which, by the kindness of Dr. L. Péringuey, the Director, I am able to describe in his words and to figure from a photograph kindly sent to me by him. Dr. Péringuey writes:—

“I very much regret to say that the extinct Quagga is represented in the collection by a foal only. The skin was never properly mounted, and the animal looks somewhat grotesque, but I dare not have this relic taxidermised. The animal was procured from the Beaufort West district of the Cape Colony *circa* 1860. It is rufous-brown, the stripes whitish, but slightly mingled with rufous, or rather tawny, on the edges. The animal is 110 cm. from nose to the root of the tail, 68 cm. at the shoulders, 70 cm. at the hind quarters; the length of the head is 30 cm. from the muzzle to the centre of the ears. The remarkable feature of the foal is the great length of the hairs; those bearding the lower jaw are 3 cm. long. On the facial part there are four distinct stripes and many outer, ill-defined ones. These show distinctly in the photograph.” (Text-fig. 171, p. 580.)

I here figure all the chief specimens of the Quagga which I have been able to find in the museums of Europe and Africa, except that at Turin\* and those said to be at Mainz and Frankfurt-on-

\* I obtained, but too late to reproduce, a picture of this specimen, by the kindness of Dr. L. Camerano, who published it (*Atti d. R. Accad. d. Scienze*, Torino, vol. xliii. pp. 3-6, pl.).

Main \*. I have arranged all the specimens in a series according to the amount of striping in each specimen. This will serve to show the relation of the Basel Quagga to those already familiar. Whenever I could ascertain the provenance of the specimen and its date, I have given it. The sequence shows that the process of self-divesting of the stripes from the hoofs upwards, which we can trace in the Burchelline Zebras from Grant's variety in North-east Africa downwards (text-figs. 144-8, *supra*), continued in operation amongst the Quaggas of Orange River and Cape Colony. Scanty as the evidence is, it renders it clear that if we had more specimens we could trace every stage in the process and we would find, that as in British East Africa the Zebras vary from area to area, so was it also with the Quaggas of Cape Colony. In addition to the reproductions of the extant specimens in museums as well as York's photograph of the female Quagga which lived in the Regent's Park from 1851 to 1872, I have reproduced the chief pictures of Quaggas drawn from living specimens. There has been in the past much discussion as to whether the drawings of Edwards, Cornwallis Harris, Hamilton Smith, and Daniell are trustworthy, because the animals portrayed differ in coloration *inter se* and also from the extant museum specimens. But a comparison of the illustrations from the pictures with those from the extant specimens, and from York's photograph, and the descriptions of such men as Cornwallis Harris, will convince the reader that the pictures of Edwards, Harris, Daniell, and Hamilton Smith, though differing from each other, and from some of the extant specimens, show forms quite in keeping with what might be expected in other specimens of Quaggas.

Cornwallis Harris, who had studied the Quagga from life in its haunts ('Wild Sports of Southern Africa,' p. 48), has left us in his 'Portraits of the Game Animals of Southern Africa' (1841) a picture of an animal (text-fig. 180, p. 586) with less striping than Daniell's (text-fig. 179). Harris was drawing from animals that he saw around him, and had he not seen such variations, he would have given us an animal striped like the skin drawn by himself (text-fig. 175, p. 583). Again Hawkins †, in his drawing from life of the Knowsley quaggas (text-fig. 174), shows animals of different degrees of striping. But his picture is in accord with the evidence of the extant skins.

III. The Vienna specimen (text-fig. 158, p. 568), a female. This specimen has been fully described by Dr. Lorenz (P. Z. S. 1902, vol. i. pp. 32 *sqq.*), with an illustration taken from a photograph made for Dr. Lorenz by Herr Custos Marktanner, of Gratz, from whose negative the photograph here reproduced is also taken (having been obtained for me by Dr. Karl Toldt, of the Vienna

\* Mr. G. Renshaw (Nat. Hist. Essays, 1904, p. 192) gives both in his list, and one at Berne (p. 191). But the Director of that Museum tells me that this is a mistake.

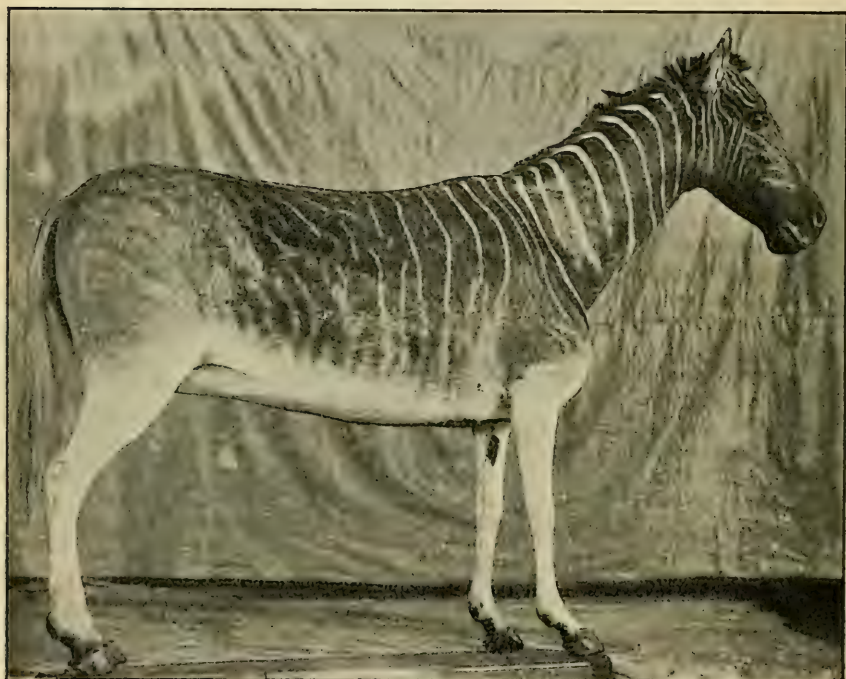
† 'Gleanings from the Menagerie and Aviary at Knowsley Hall' (J. E. Gray and Waterhouse Hawkins: Knowsley, 1851).



Museum, in 1906). The specimen was procured by Ecklon in 1836 (who had purchased for Munich its specimen in 1835).

IV. **The Tring specimen** (text-fig. 159). Dr. P. L. Slater, F.R.S., described and figured this specimen (P. Z. S. 1901, vol. i. p. 166). My illustration is from a photograph given by the Hon. Walter Rothschild, M.P. to Mr. R. I. Pocock, who has kindly allowed me to embody the following notes on this important specimen (pp. 569-70). Dr. Slater stated that this

Text-fig. 158.



The Vienna Quagga (female), 1836.

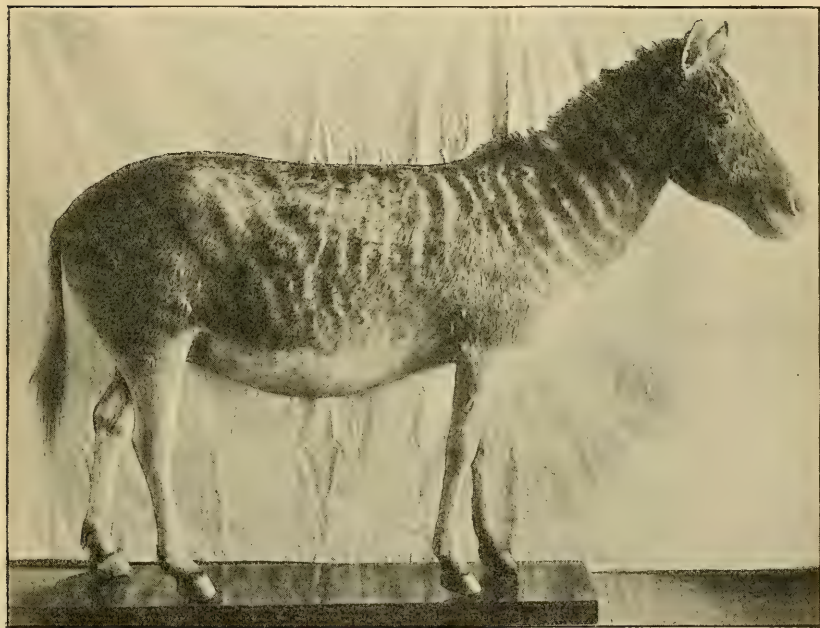
specimen was the animal which lived in the London Zoological Gardens from 1851 to 1872. I am also indebted to Mr. Pocock for the facts relating to the history of this specimen and its supposed identity with either the quagga which died in the Regent's Park in 1864 (Sir G. Grey's specimen) or the one which died in 1872. The question is fully discussed (*infra*, pp. 572-5) where I treat of the British Museum specimen and that photographed by Fred. York.

"The chief points to be noticed about this Quagga are the following. The general colour is practically the same as in the



type of *E. quagga greyi* in the British Museum, that is to say, the stripes are dark brown, the interspaces paler creamy brown, the belly and legs whitish with a dark rim above the hoofs and dark hair at the back of the fetlocks. The stripes on the neck are moderately broad and some of them at least are double. The lower half of the shoulder is unstriped; and on the anterior portion of the body behind the shoulders the stripes are short, but posteriorly they become progressively longer and retain their distinctness as far back as the hind-quarters, exhibiting most clearly in the posterior

Text-fig. 159.



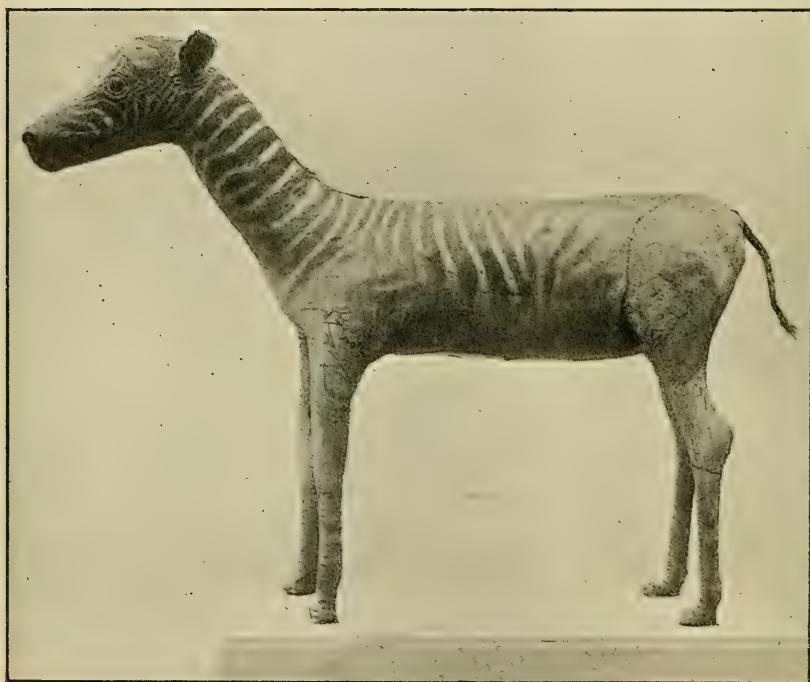
The Tring Quagga.

half of the body the backward inclination so characteristic of so-called Zebras of the Burchelline group. The last long stripe that is visible slopes backwards from a point a little in front of the stifle-joint towards the root of the tail, and appears to represent the stripe in a specimen of Chapman's Quagga which Prof. Ewart called the "intermediate flank stripe." Below this the hind-quarters seem to show traces of at least one abbreviated stripe, recalling the abbreviated stripes on this area in typical *E. quagga burchelli*.

"It is the persistence and distinctness of both the vertical and oblique stripes on the body that make the Tring Quagga exceptionally interesting. In these particulars, coupled with the width

of the interspaces between the stripes on the body and neck, it more resembles some of the recorded examples of *E. quagga burchelli* than any of the extinct Quaggas hitherto described and figured. It surpasses even the Vienna specimen in the cogency of the evidence it supplies of the closeness of the affinity between the extinct and existing members of this species. Apart, indeed, from its browner tint, due to the lightening of the stripes and the darkening of the interspaces, I cannot detect one single important character in which this Quagga differs, for example, from the specimen of Burchell's Quagga in the Bristol Museum.

Text-fig. 160.



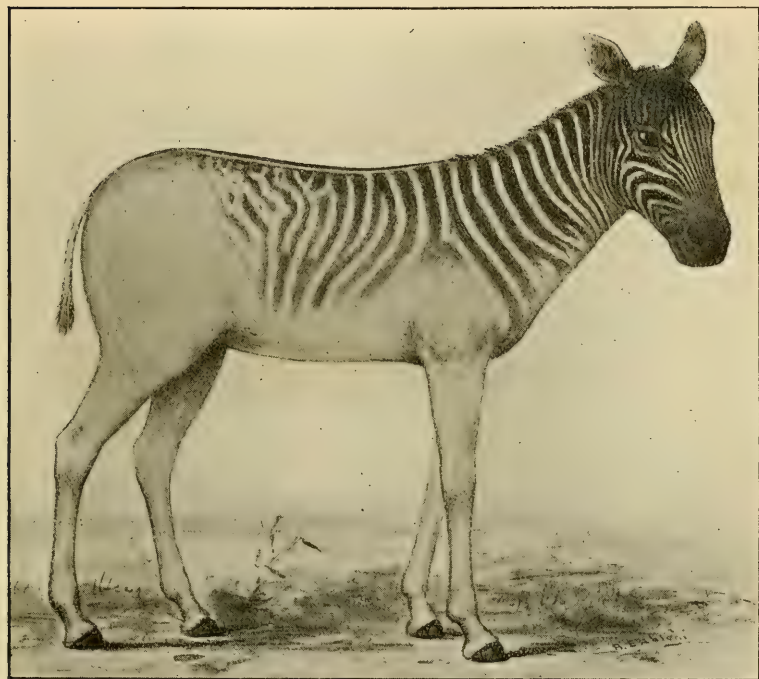
The Stockholm (Sparrman's) Quagga, 1775.

"I am greatly indebted to Mr. Rothschild for giving me more than one opportunity of examining this Quagga at Tring and also for very kindly supplying me with a photograph of the animal from which Prof. Ridgeway has had the subjoined block prepared."

**V. The Stockholm specimen** (text-figs. 160 & 161). This specimen has a peculiar interest, as it is not only the oldest extant specimen, but is the "full-grown foetus" brought home by

Sparrman in 1775\*. For the two illustrations I am indebted to my friend Prof. Dr. Lönnberg, the Keeper of the Natural History Museum, Stockholm, who has also given me the notes here embodied. Text-fig. 160 is from a photograph taken before the dust of a century was removed from the animal. Text-fig. 161 is from a painting made by the Stockholm artist Mr. S. Ekblon for Dr. Lönnberg of the specimen after it was cleaned. Dr. Lönnberg has most generously put this picture at my disposal, and he tells me

Text-fig. 161.



The Stockholm (Sparrman's) Quagga (from a painting).

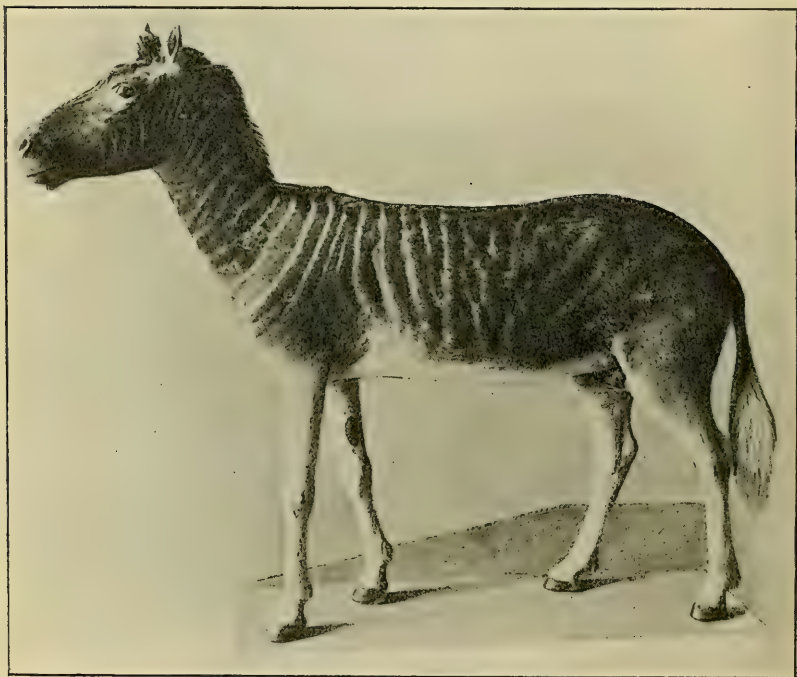
that "it represents a careful copy of the pattern of the right side, which is not fully identical with that on the left" (represented by the photograph, text-fig. 160). "The light patch on the rump in the photograph is due to the fact that the specimen had not been fully cleaned when the photographer had it." In answer to my query Dr. Lönnberg writes that "the brown of the stripes may be a little bleached, but only a little; the light ground colour is of

\* 'Voyage to Cape of Good Hope, etc.', Engl. trans. (Perth, 1789), vol. i. p. 190. Sparrman gives its measurements: "from ears to tail 31 inches; height at loins 22."

course not altered. Sparrman says in his narrative that the colours of this fetus were 'fresher,' *i. e.* brighter, than in full-grown animals of the same kind." The exact locality is not mentioned, but Sparrman relates that he saw the first quagga at Swellendam, and in this connection he mentions this fetus, although he says only that he brought it home "from the Cape."

VI. **The Wiesbaden specimen** (text-fig. 162) was bought in 1865 from Frank, the Amsterdam dealer, for one hundred florins. It is a male. The provenance is simply "South Africa."

Text-fig. 162.



The Wiesbaden Quagga (male), 1865.

This information and the photograph I owe to the kindness of Dr. Lampe, Custos of the Wiesbaden Museum.

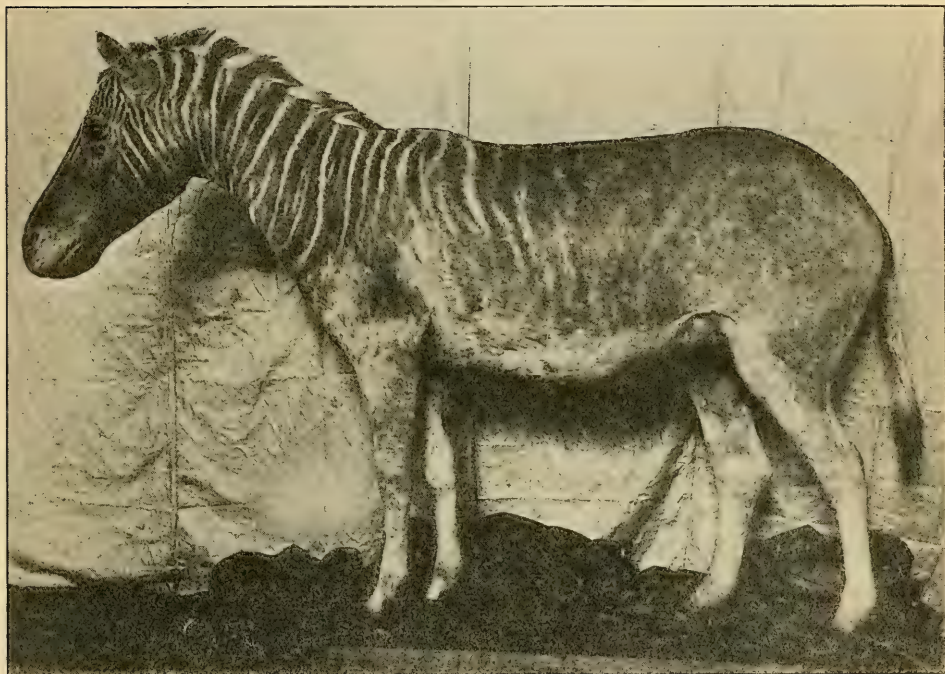
VII. **The British Museum specimen** (text-fig. 163). Mr. Lydekker ('Guide to the Specimens of the Horse Family (Equidæ),' p. 34), writes:—"The species is represented in the collection by the mounted skin and the skeleton of a male formerly living in the Zoological Gardens, Regent's Park. That animal, which was one of the last survivors of the species, was presented to the



Zoological Society by Sir George Grey, K.C.B., in 1858, and lived in the Menagerie in the Regent's Park till June 1864. The skin is exhibited in case no. 38 in the lower mammal gallery, and the skull on the opposite side of the same case."

Between this specimen and that at Tring there has been much confusion. In the P. Z. S. 1901, vol. i. p. 165, Dr. P. L. Slater, F.R.S., stated that the female Quagga purchased on March 15th, 1851, by the Zoological Society died on July 7th, 1872, and was sold to Mr. E. Gerrard, and is now in the Zoological Museum at Tring. A photograph of this animal taken during its lifetime

Text-fig. 163.



The British Museum (Grey's) Quagga (male), 1858.

(1870) by York is reproduced on p. 166 of the volume just cited. Mr. Pocock accepted this statement as correct and reprinted it in his paper on the Cape Colony Quagga (*Ann. Mag. Nat. Hist.* (7) xiv. p. 324, 1904).

The Hon. Walter Rothschild, M.P., then wrote to Mr. Pocock to tell him that he had bought the Tring Quagga from Gerrard in 1889, understanding that it had been received in exchange from the Dresden Museum. Mr. Pocock wrote to Mr. Gerrard, and he informed Mr. Pocock that it came from the Leyden Museum.

Mr. Pocock wrote to Dresden, and the then Director replied that the Dresden Museum had never possessed a Quagga, and had never sold one to Gerrard either before, during, or after 1889.

All doubt on this matter is removed by the following letter from Gerrard to Mr. Pocock :—

Natural History Studios,  
61 College Place, Camden Town,  
London, N.W.,  
June 12th, 1909.

Dear Sir,

The Quagga I sold to Tring was one I bought from Mr. Frank of Amsterdam. It was an old mounted specimen, and I remounted it. I do not know where Frank got it. The Quagga which died at the Zoo was made into a skeleton. The skin was bad. The skeleton is in the British Museum.

Yours truly,

EDW. GERRARD.

Dr. Harmer, F.R.S., on recently examining the specimen in the British Museum and comparing it with the animal shown in York's photograph, told me that he doubted if they were one and the same animal.

Mr. G. Dollman has kindly sent me the extract\* from the Museum Register. It puts beyond doubt that the specimen is Grey's which died in 1864, years before York's photograph. Mr. Gerrard is therefore wrong, and so is Dr. Renshaw †, who states that the Museum specimen is the animal which died in the Gardens in 1839.

The statements prove the following conclusions :—

(i) In 1851 the Society purchased a *female* Quagga which died in 1872.

(ii) The skin was not preserved being in a bad state, but its skeleton was mounted, though it is not that now in the Natural History Museum.

(iii) In 1858 Sir George Grey presented to the Zoological Society a *male* Quagga which died in 1864. It is the mounted skin, skull and skeleton of this *male* which is now in the British Museum.

(iv) It is certain that York's photograph represents a specimen which was living in the Regent's Park. But as this photograph does not represent the stuffed specimen in the British Museum (Sir G. Grey's male), it must represent the female specimen bought in 1851, of which the skeleton was preserved but not the skin, which was in too bad a state.

(v) The Tring specimen is neither the female specimen which was in the Gardens from 1851 to 1872, nor the male presented by Sir G. Grey in 1858 and which died in 1864. It is the skin of a quite different animal.

(vi) Thus through the efforts of Mr. Pocock and Dr. Harmer's

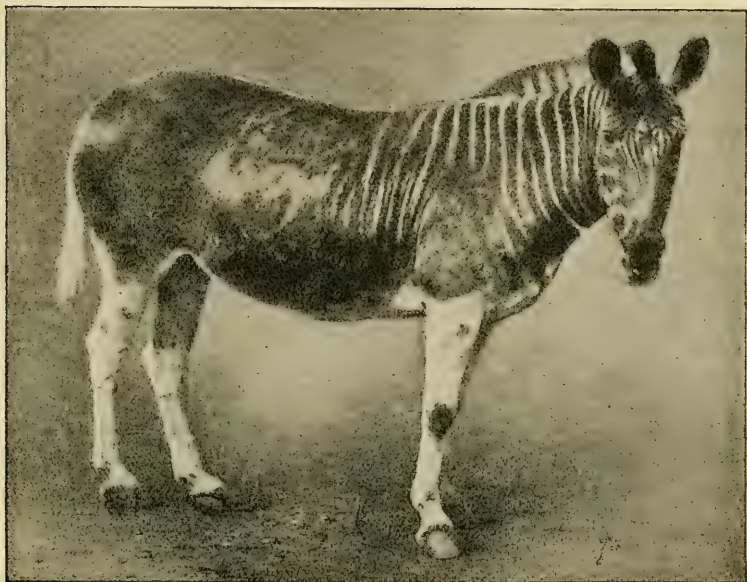
\* The entry runs : "64.7.23, Reg. no. *Equus quagga*, male, stuffed skin and skeleton, purchased of the Zool. Soc. (Sir George Grey, 1858)."

† Nat. Hist. Essays, pp. 186-7.

sagacity we are enabled to add another specimen to the list of Quaggas preserved in our museums. Most fortunate it was that York photographed the female Quagga in the Gardens, for although her skeleton may be preserved in some museum, all record of her external appearance would have been lost.

VIII. **The Female Quagga photographed by York** (text-fig. 164). For this illustration I have to thank the Director of the British Museum, who has permitted me, with Mr. Lydekker's approval, to reproduce the fig. 22 in the 'Guide to the Specimens

Text-fig. 164.



Female, Regent's Park (1851-72). Photographed from life by F. York.

of the Horse Family' (p. 33). From what has been said under "The British Museum specimen" *supra*, it is clear that York's photograph, taken (1870 or 1872) from the only living quagga ever photographed, represents the female which lived in the Gardens from 1851 to 1872, and not the specimen now in the British Museum.

IX. **The Edinburgh specimen** (text-fig. 165). The Edinburgh specimen has no provenance except Cape of Good Hope. It was purchased by the University of Edinburgh for their "College Museum" during the year ending June 1818, for the sum of one guinea, and it was afterwards transferred to the Royal Scottish



Museum, where it now is along with the rest of the old College Collection. I am indebted to the Director, Dr. Dobbie, F.R.S., and to Mr. G. P. H. Grimshaw for the photograph and information.

Text-fig. 165.



The Edinburgh Quagga, 1818.

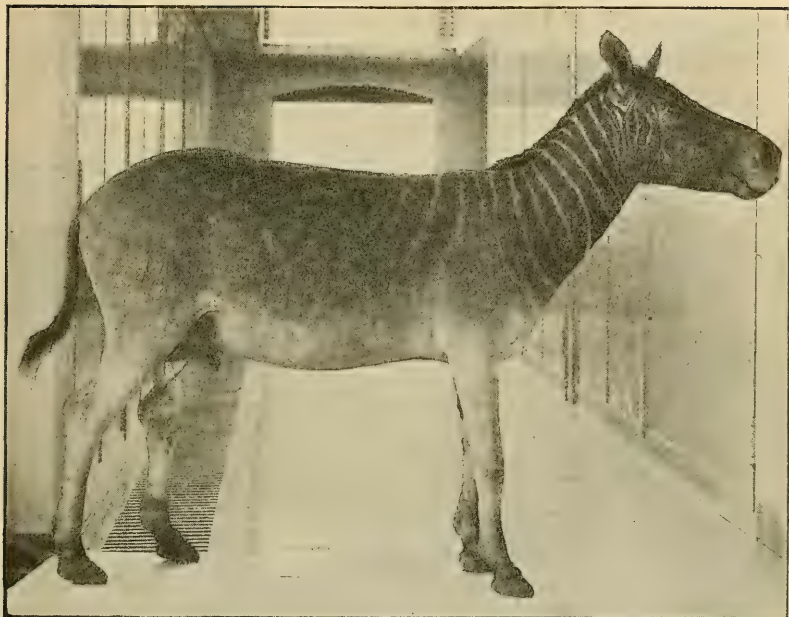
X. **The Leyden specimen** (text-fig. 166) is from a photograph kindly given to me by my friend Dr. F. A. Jentink, F.M.Z.S., the Director of the Dutch State Museum of Natural History at Leyden. The animal was shot near Steenberg by Dr. van Horstok on June 15th, 1827. The skeleton of this fine animal (male) is likewise in the Leyden Museum.

XI. **The Paris specimen** (text-fig. 167) is from a photograph kindly given to me by Dr. Trouessart, the Director of the Paris Natural History Museum, to whom I am also indebted for the following account:—"Le quagga est venu (vivant) lors de la création de la ménagerie du Muséum de l'ancienne ménagerie du Roi à Versailles en 1793. A cette époque l'indication 'Cap de Bonne Espérance' semblait très suffisante." Dr. Trouessart has since published the specimen with an illustration in the 'Bulletin' \* of the French National Museum.

\* 1906, xii, p. 449.

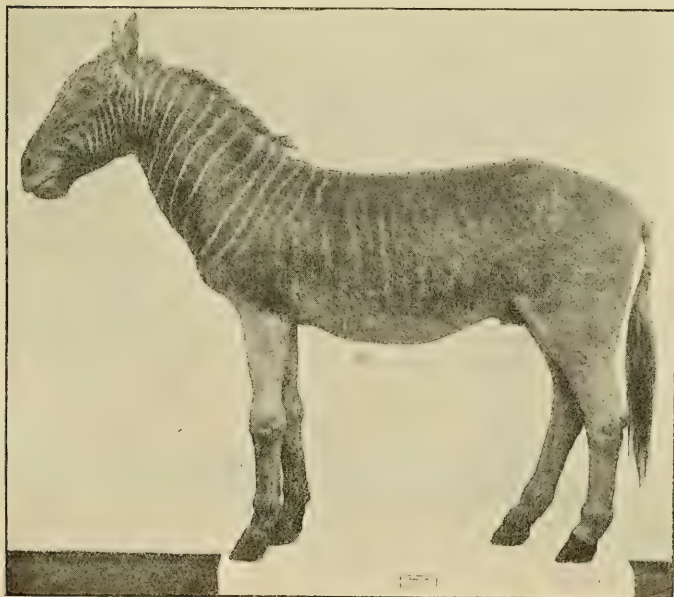


Text-fig. 166.



The Leyden Quagga (male), Steenbergen, 1827.

Text-fig. 167.



The Paris Quagga, 1793.

XII. **The Berlin Quagga** (text-fig. 168), a female, is that which died in the Berlin Zoological Garden in 1875. The skull and skeleton are also in the Berlin Museum as well as two other quagga skulls. Dr. Matschie, who kindly gave me the photograph,

Text-fig. 168.



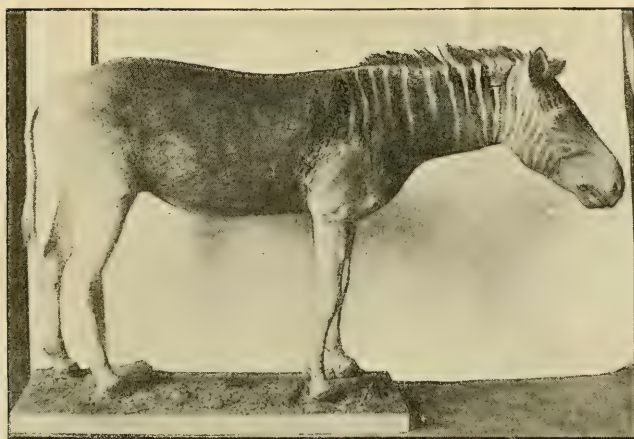
The Berlin Quagga (female).

informs me that the specimen has not been fully described. He considers that it belongs to the same type as the Vienna (*E. lorenzi*). "The ground-colour is burnt-umber; the bright stripes are very bright brown (sehr hell braun)."

XIII. **The Munich specimen** (text-fig. 169).—The illustration is from a photograph kindly sent to me by Dr. Hertzog, the Director of the Natural History Museum. The specimen was purchased by Ecklon in 1835, who in the following year procured the Vienna specimen.

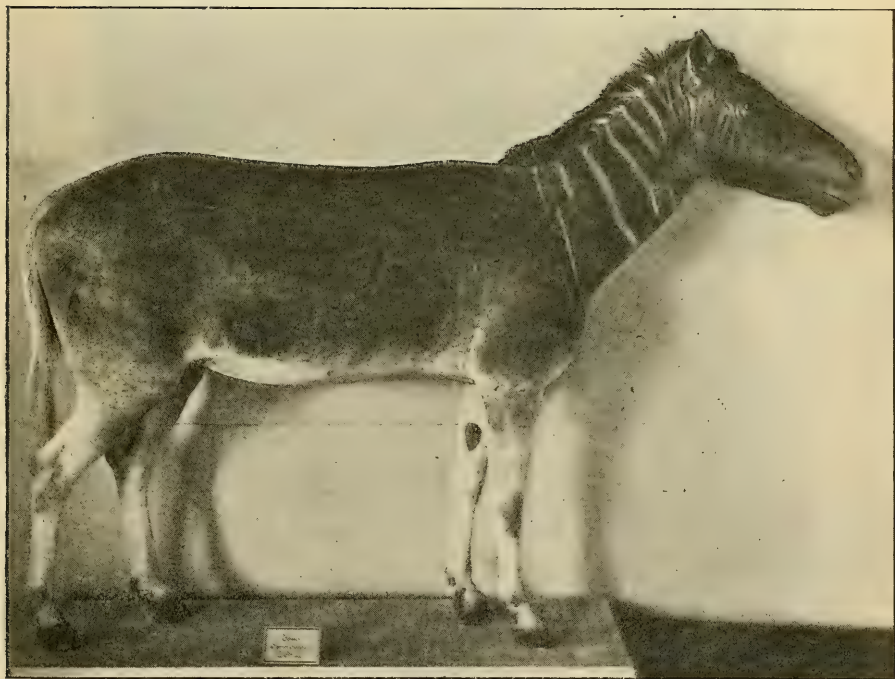
XIV. **The Amsterdam Quagga** (text-fig. 170).—The illustration is from a photograph kindly given to me by Prof. Dr. Kerbert. The specimen has been described and discussed by Mr. Lydekker (P. Z. S. 1904, vol. i. p. 430, text-fig. 86).

Text-fig. 169.



The Munich Quagga, 1835.

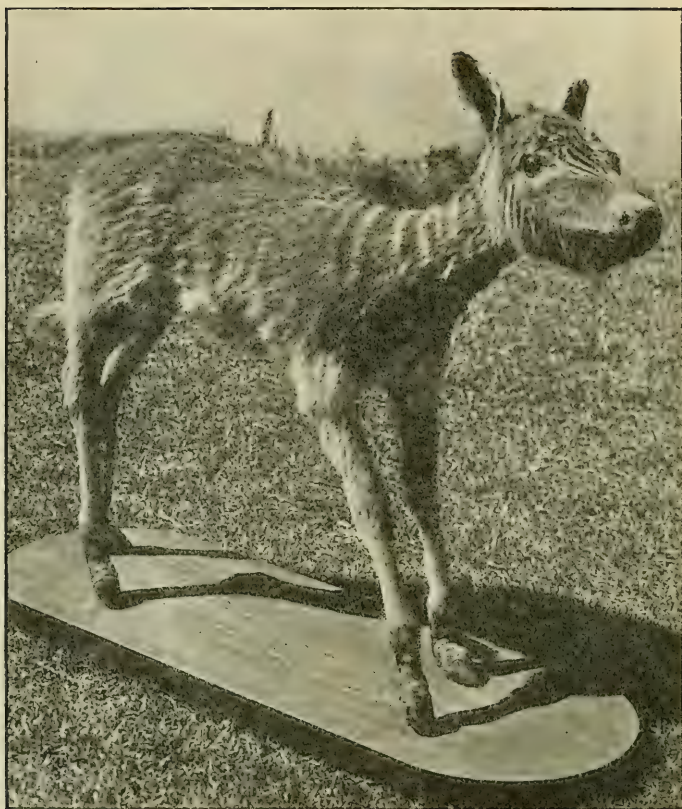
Text-fig. 170.



The Amsterdam Quagga.



## Text-fig. 171.



The Cape-Town Quagga foal, Beaufort West, about 1860.

XV. **The Elgin Quagga** (text-fig. 172).—I published this head and neck in my 'Origin and Influence of the Thoroughbred Horse' (pp. 438 & 9, figs. 131–3), 1905.

1. **Edwards' Quagga**.—The illustration (text-fig. 173, p. 582) is from the drawing made by G. Edwards himself "from the living animal belonging to His Royal Highness the Prince of Wales" in 1751, and published in his 'Gleanings of Natural History,' London, 1758, p. 29, pl. 223. This drawing was reproduced and discussed by Mr. R. I. Pocock (Ann. Mag. Nat. Hist., Nov. 1904).

The figure is that given in my 'Origin and Influence of the Thoroughbred Horse,' p. 72, fig. 38.



Text-fig. 172.



Elgin Quagga: Kingwilliamstown, 1861.

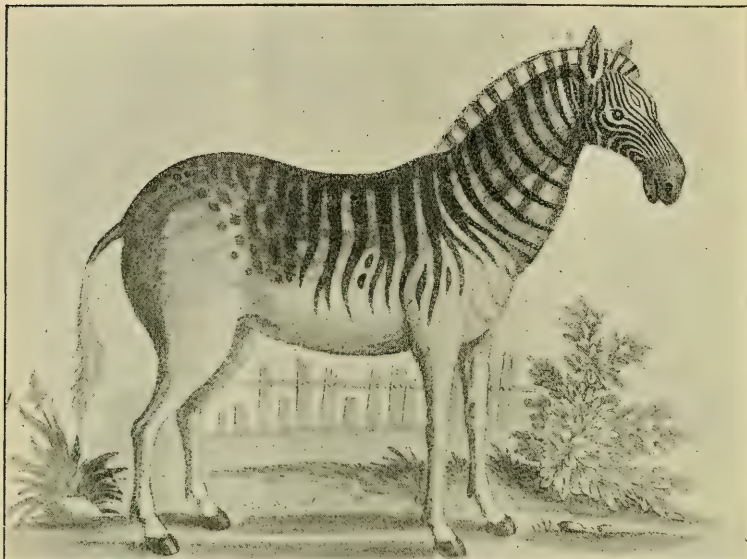
2 and 3. **The Knowsley Quaggas** (text-fig. 174, p. 582).—My illustration is from their portraits by Hawkins (*supra*, p. 567) in the 'Knowsley Menagerie.' The two animals are shown on one picture. One is more striped than the other, but the skin (text-fig. 175) might belong to a similar animal.

4. **Cornwallis Harris' Drawing of a Quagga Skin** (text-fig. 175), *cf.* p. 567. It is reproduced from the 'Portraits of the Game Animals of Southern Africa.'

5. **Lord Morton's Quagga.**—My illustration (text-fig. 176) is from a block made from Agasse's drawing for my friend Prof. J. Cossar Ewart, F.R.S. ('Penicuik Experiments,' p. 65).

This animal belonged to Lord Morton in 1821 (see *Phil. Transactions*, 1821, p. 21). (*Cf.* 'Origin and Influence of the Thoroughbred Horse,' p. 457.)

Text-fig. 173.



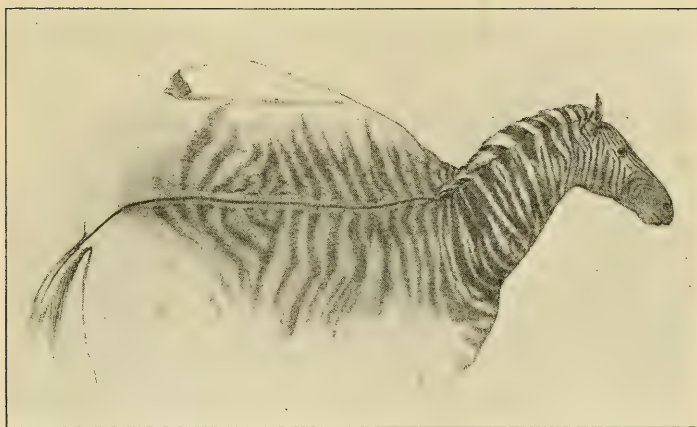
Edwards' Quagga, 1751 (from Edwards' drawing).

Text-fig. 174.



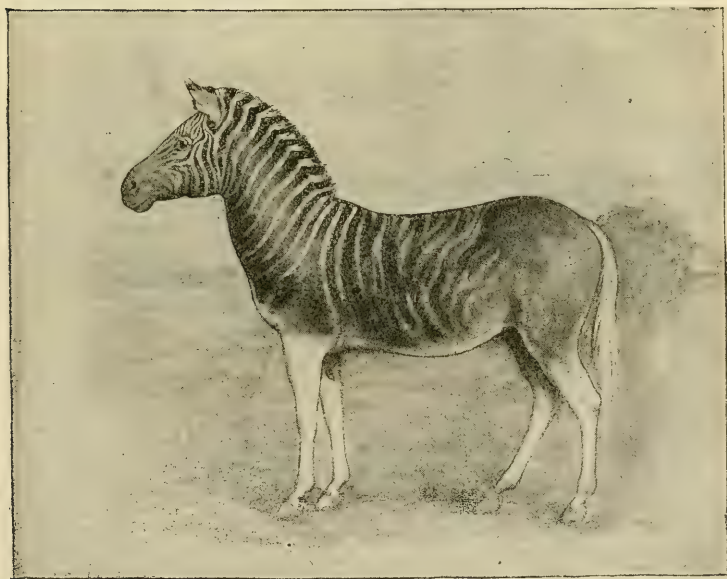
The Knowsley Quaggas, from Hawkins' drawing.

Text-fig. 175.



From Cornwallis Harris' picture  
(*'Portraits of the Game Animals of Southern Africa'*).

Text-fig. 176.



Lord Morton's Quagga, 1821 (from Agasse's drawing).

6. Buffon's Quagga.—My illustration (text-fig. 177) is from that in Buffon's 'Histoire Naturelle,' vol. x. p. 112 *sqq.*, pl. ii. (1787). The description of the quagga there given and the drawing from which the engraving was taken (here reproduced)

Text-fig. 177.



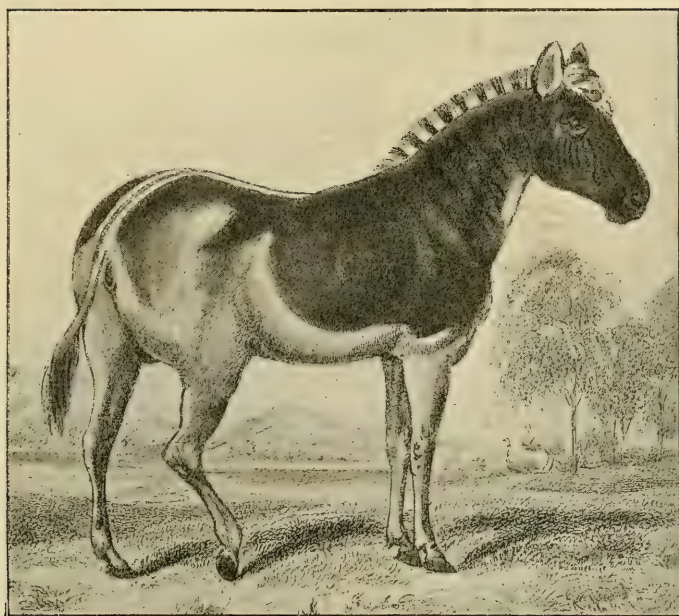
Buffon's Quagga: from Gordon's drawing.

were obtained from a Mr. Gordon, who (dans le pays des Bosjemans fort éloigné de toute habitation) made a drawing from a young quagga, which he had cut off from a herd of females with their foals, and which followed his horse (p. 115).

7. Hamilton Smith's Quagga (*supra*, p. 567). (Text-fig. 178.)

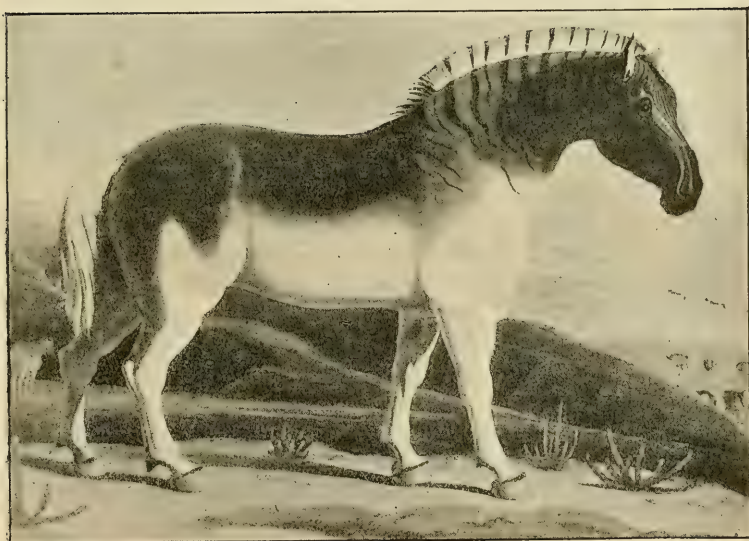


Text-fig. 178.



Hamilton Smith's drawing, 1840 \*.

Text fig. 179.



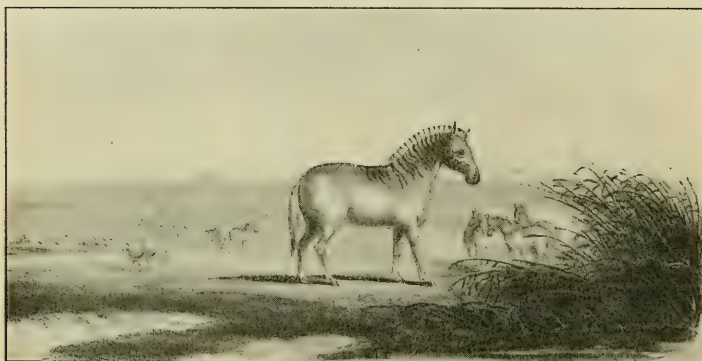
Daniell's Quagga : from a drawing anterior to 1804.

\* 'Horses,' pl. xxiv.

8. **Daniell's Quagga**.—The illustration (text-fig. 179, p. 585) is a reduced facsimile from the drawing by Samuel Daniell in his 'African Scenery' (1804–8), no. 15. The picture has been reproduced and discussed by Mr. Pocock (Ann. Mag. Nat. Hist., Nov. 1904).

9. **Cornwallis Harris's Quagga** (text-fig. 180) is a reproduction of Harris' drawing in the 'Portraits of the Game Animals of Southern Africa' (*supra*, p. 567).

Text-fig. 180.



From Cornwallis Harris' drawing.

This survey of the extant skins and the pictures of the Quaggas of Orange River and Cape Colony, and the comparison of the illustrations with those of the Burchelline Zebras, leads irresistibly to the conclusion that every area has its own variety due to environment, that we must be slow to make new species or even subspecies, and that Mr. Pocock was right in maintaining that the Quaggas of Orange River and Cape Colony were not specifically distinct from the Burchelline Zebras.

3. Contributions to the Study of the Equidæ; iii. On a portion of a fossil Jaw of one of the Equidæ. By Prof. WILLIAM RIDGEWAY, M.A., Sc.D., F.B.A., LL.D., Litt.D.\*

[Received April 21, 1909.]

(Text-figure 181.)

By the kindness of Mr. A. C. Hollis, secretary to the High Commissioner of British East Africa, through my friend Mr. C. W. Hobley, C.M.G., Assistant-Commissioner at Nairobi, I am

\* Communicated by Dr. P. CHALMERS MITCHELL, M.A., F.R.S., F.Z.S.

enabled to publish a most interesting fragment of the fossil jaw of what was undoubtedly one of the Equidæ. It was found in 1906 "by a Mr. W. A. Macgregor in the Morendat River near Naivasha." Mr. Macgregor gave it to Mr. Hollis. I am informed by Professor Gregory of Glasgow, who has worked in British East Africa, that the gravels of the Morendat are late Tertiary. The fragment here shown (text-fig. 181) is the fore part of the under jaw. Unfortunately it does not extend back beyond the diastema and include any of the premolars or molars, but five of the six incisors survive and also the canine on the right side, the canine and second corner incisor on the left side being lost.

Text-fig. 181.



Fragment of a fossil jaw ; River Morendat, British East Africa.

Allowing for the loss of a small portion, the breadth across the jaw at the corner incisors is exactly two inches. The distance from the corner incisor to the canine is very small, not more than a quarter of an inch. This specimen is very interesting as it is, so far as I know, the only fossil remains of a mammal as yet obtained from British East Africa, and at the time of its discovery was the first from any part of East Africa. But the Germans have lately made some discoveries. The only mammal fossil from Central Africa as yet known, is a fossil tooth of a giraffe.

Close to the area where it was found there still survive representatives of all three species of Zebra—*E. zebra* or the Mountain



Zebra, Grant's variety of Burchell's Zebra, and Grévy's Zebra; and it is not improbable that in this jaw we have a relic of an ancestor of one or more or of all these species.

Is it possible to form any estimate of the size of this animal, which I propose to call *E. hollisi*?

Let us compare the few measurements which we can make with those of its living relatives. The distance across the four completely surviving incisors in the fossil is one and three-quarter inches. The same measurement in my skull of a Grévy stallion gives two inches, and in that of my Grant stallion two and three-eighths inches. The interdental space between the canine and the nearest incisor in the fossil *E. hollisi* is about a quarter of an inch, in the Grévy three-eighths, in the Grant nearly an inch. Thus, so far as these very inadequate measurements indicate, the animal was more like the Grévy Zebra than the Grant, an inference quite in keeping with the view that the stripe-system in the Grévy is much older than in the Burchell family of Zebras.

As regards the actual size of the *Equus hollisi*, we can form no estimate from the jaw measurements. Thus the Grévy stallion, the measurements of the jaw of which I have just cited, stood 4 feet 9½ inches (14·1½ hands) or just the height of the true Libyan horse, that is the small "Arab" not increased in height by crossing with Asiatic horses. On the other hand, the Grant's Zebras of East Africa seldom reach more than 4 feet 2 inches (12·2 hands), yet the measurement of the front of the jaw in the latter is distinctly larger than that of the Grévy stallion. Thus from the present scanty data, we cannot form any estimate of the height of *E. hollisi*, for although the front of the lower jaw is much smaller than that of *E. granti*, it is quite possible that it, like the Grévy Zebra, may have been a much larger animal.

#### 4. On a New Race of Deer from Sze-chuen.

By R. LYDEKKER\*.

[Received April 8, 1909.]

(Plate LXIX.†)

Shortly before his death, I received from the late Mr. J. W. Brooke a communication regarding a so-called "white deer" inhabiting Sze-chuen, which was stated to be no albino, but, in my correspondent's opinion, a new species. In February of the present year, Captain Malcolm McNeill called at the Natural History branch of the British Museum, and informed me that he had just returned from Sze-chuen, where he had seen a small party of these deer, out of which he succeeded in shooting a hind.

\* Communicated by permission of the Trustees of the British Museum.

† For explanation of the Plate see p. 590.





CMP-EEJ

Miles & C<sup>o</sup> Imp

SZE-CHUEN HANGUL (FEMALE)  
CERVUS CASHMIRIANUS MACNEILLI



Of this hind he brought home the skin, skull, and limb-bones, which have been secured for the British Museum and form the subject of the present communication. Captain McNeill described the deer as being nearly the size of a Wapiti; and this estimate seems to be approximately borne out by the skull and skin, the former of which, although immature, is rather larger than the skull of an adult red deer hind. Unfortunately, Captain McNeill was unable to furnish any information with regard to the form of the antlers of the stag.

The general characters of the skin indicate a deer akin to the Hangul (*Cervus cashmirianus*) of Kashmir and Kishtwaz. The coat is, for instance, of the same dense and close character, with the individual hairs ringed with dark and light in their terminal halves, so as to give a speckled appearance to the body-fur. There is the same narrow white area on the buttocks, bordered by a darkish band, which is continued down the middle line of the short tail, and there is a similar dark mane on the neck, continued as a dark line for some distance down the back.

The Sze-chuen deer is, however, a much lighter-coloured and a more fully speckled animal than the typical Hangul. The general colour is grey fawn, becoming paler on the limbs, of which the backs and inner sides are nearly white. The individual hairs on the body have also a greater number of light rings; and the speckling is as well-developed on the flanks and neck as on the back, whereas in the Kashmir Hangul the speckling is almost obsolete in the regions first-named. In both forms the tips of the hairs are, however, always light, although on the flanks and neck of the Kashmir stag these tips are but little paler than the general body-colour. On the back the dorsal stripe of the new deer stops short a little behind the shoulder, instead of continuing as a more or less distinct line to the rump. The Sze-chuen deer lacks the white under-lip of its Kashmiri relative; but, on the other hand, the whole throat is much lighter than the general body-colour, instead of being quite as dark, or darker, in the stags, at any rate, of the typical Hangul. Then again, the whole of the under-parts of the Sze-chuen deer are dirty white, whereas in the Kashmiri animal the abdomen alone is white, while the lower surface of the chest is darker than the back. Certain differences are observable in regard to the extent of the white and black of the buttocks when the Sze-chuen skin is compared with those of the Kashmir Hangul in the Museum, but these may be merely individual. The gland on the hind cannon-bone is pale chestnut in the new deer, and thus shows out, against the grey fawn, much more conspicuously than in the typical Hangul.

The skin of a second hind in the possession of Captain McNeill agrees in all essential characters with the specimen described.

So far as the present specimens go, the Sze-chuen deer may be defined as follows:—

Allied to *Cervus cashmirianus*, but much paler and more profusely speckled; the general colour being grey fawn, becoming

whitish fawn on the throat and limbs, and the speckling as fully marked on the neck and flanks as on the back. No white on the chin; but the whole of the under-parts dirty white, instead of merely the abdomen. Dark dorsal line stopping short about the middle of the back.

For the present, at any rate, I propose to regard the Sze-chuen "white" deer as a race of the Hangul, under the title of *Cervus cashmirianus macneilli*. The occurrence in Sze-chuen of a representative of the Hangul is paralleled by the occurrence in the same province of a local race of the Sambar.

#### EXPLANATION OF PLATE LXIX.

*Cervus cashmirianus macneilli*, from the type female from Sze-chuen in the British Museum (Natural History).

### 5. The Batrachians and Reptiles of Matabeleland.

By E. C. CHUBB, F.Z.S.

[Received April 28, 1909.]

The following list is based entirely upon material in the Rhodesia Museum, Bulawayo, and is intended to give some idea of the Batrachia and Reptilia inhabiting this region, although it cannot claim to be more than tentative, for as soon as extensive collections are made in various parts of the country there will, no doubt, be many species to add.

The localities vary in altitude between 2000 and 4500 feet; the latter figure representing the height of Bulawayo.

In a previous paper dealing with the Mammals of this area\* an allusion was made to the probability of the various geological formations supporting distinct faunas, and this appears to be borne out to a remarkable extent by the lizards, no single species of which has as yet been found common to our two principal local formations, viz., granite and schist. Below is given a list of those forms which I have had an opportunity of observing in their haunts; it is arranged to show their habitats according to these two formations.

#### GRANITE.

*Homopholis wahlbergii*.

*Pachydactylus affinis*.

*Agama kirkii*.

*Platysaurus guttatus*.

*Gerrhosaurus validus*.

*Mabuia quinquetaeniata*.

„ *varia*.

#### SCHIST.

*Pachydactylus bibronii*.

*Agama distantii*.

„ *atricollis*.

*Gerrhosaurus flavigularis*.

*Mabuia striata*.

\* P. Z. S. 1909, p. 113.



The Matabele names are given wherever it has been possible to ascertain them with certainty, but the natives are not so well acquainted with the names of lizards and snakes as they are with those of mammals and birds. In reading these, it must be remembered that "c," "q," and "x" represent clicks, as in Zulu.

Among the numerous donors of specimens to whom the Museum is indebted, should be specially mentioned Messrs. R. Edge and G. Dally for collections made in the vicinity of Bulawayo.

I must express my warmest thanks to our Vice-President, Mr. G. A. Boulenger, F.R.S., who has been good enough to examine the collection and confirm or correct my determinations.

### BATRACHIA.

#### 1. BUFO REGULARIS Reuss.

- a.* Bulawayo.
  - b, c.* Crombie's Store, 16 miles S.E. of Bulawayo, 18 Oct. 1907.
  - d.* World's View, Matopos, April 1908.
- "Ixoxo" is used for all frogs and toads.

#### 2. BUFO CARENS A. Smith.

- a.* Bulawayo.
- b-e.* Crombie's Store, 18 Oct. 1907.
- f.* Kana River, 20 Nov. 1907.

#### 3. PHRYNOMANTIS BIFASCIATA A. Smith.

- a.* Bulawayo, 3 Dec. 1907.
- b.* Shangani River, 23 Nov. 1907.
- c.* Gonda's, Shangani River, 3 Dec. 1907.

#### 4. BREVICEPS MOSSAMBICUS Peters.

- a-c.* Bulawayo.
- d, e.* Near Gwamayaya River, 21 Nov. 1907.

#### 5. RANA DELALANDII D. & B.

- a-c.* Bulawayo.
- d.* Gwamayaya River, 13 Nov. 1907.

#### 6. RANA ANGOLENSIS Bocage.

- a.* Bulawayo, 6 Sept. 1907.
  - b.* Crombie's Store, 18 Oct. 1907.
  - c, d.* World's View, Matopos, April 1908.
  - e, f.* Gwamayaya River, 13 Nov. 1907.
- A number of tadpoles were taken with "b" on Oct. 18th.

#### 7. RANA ADSPERSA Bibr.

- a-d.* Bulawayo.
- e.* Gwamayaya River, 22 Nov. 1907.

8. *RANA MASCARENIENSIS* D. & B.

*a.* Swena's, Gwamayaya River, 22 Nov. 1907.

9. *PHRYNOBATRACHUS NATALENSIS* A. Smith.

*a.* World's View, Matopos, April 1908.

*b-r.* Kana River, 20 Nov. 1907.

*s-x.* Gwamayaya River, 13 Nov. 1907.

10. *CASSINA SENEGALENSIS* D. & B.

*a.* Kana River, 20 Nov. 1907.

11. *CHIROMANTIS XERAMPELINA* Peters.

*a.* Victoria Falls.

This species was observed to change colour in different lights after the manner of a chameleon, though to a less degree.

## REPTILIA.

## CHELONIA.

1. *CINIXYS BELLIANA* Gray.

*a.* Near Shangani River, Nov. 1907.

*b, c.* Essexvale, March 1909.

"Ufutu" is the name applied to all tortoises.

2. *STERNOTHELÆRUS NIGRICANS* Donnd.

*a.* Near Gwamayaya River, 22 Nov. 1907.

*b.* Near Gwelo River, 24 Nov. 1907.

3. *TESTUDO PARDALIS* Bell.

*a.* Near Gwamayaya River, 23 Nov. 1907.

## EMYDOSAURIA.

4. *CROCODILUS NILOTICUS* Laur.

The crocodile is common in most of the rivers.

"Ingwenya."

## LACERTILIA.

5. *LYGODACTYLUS CAPENSIS* A. Smith.

*a.* Bulawayo, 24 Oct. 1907.

6. *HOMOPHOLIS WAHLBERGII* A. Smith.

*a.* World's View, Matopos, April 1908.

*b.* Mazeppa Mine, Gwanda.

The first example was obtained from a hole in the trunk of a tree; the species is probably arboreal.

7. *PACHYDACTYLUS BIBRONII* A. Smith.*a.* Bulawayo.*b.* Springvale Farm, 16 miles S.E. of Bulawayo, 10 June 1907.

This is our commonest gecko; it is usually found in houses and huts.

"Amacanda-pobolo."

8. *PACHYDACTYLUS AFFINIS* Blgr.*a.* Rhodes' Park, Matopos, April 1908.9. *AGAMA ACULEATA* Merr.*a.* Bulawayo, March 1907.

All our species of *Agama* possess the property, to a greater or less extent, of changing their colour.

10. *AGAMA DISTANTI* Blgr.

This is the commonest *Agama* at Bulawayo. It runs about the ground during the heat of the day, and at other times lives in holes, usually under stones, where its eggs are laid during October and November.

11. *AGAMA KIRKII* Blgr.*a, b* (♂, ♀). Mt. Silozi, Matopos, April 1908.*c-e.* Khami River, Oct. 1907.

Lives among the rocks and is commonly found on granite kopjes.

12. *AGAMA ATRICOLLIS* A. Smith.*a-f.* Bulawayo, Sept. 1907.

Arboreal and common.

"Untulo."

13. *ZONURUS CORDYLUS* Linn.*a.* Bulawayo, 27 Sept. 1907.14. *PLATYSAURUS GUTTATUS* A. Smith.*a-g* (♂, 6 ♀). Mt. Silozi, Matopos, April 1908.*h, i* (2 ♀). Colleen Bawn Mine, Gwanda, Dec. 1908.

Found only on the granite kopjes where it is fairly common.

15. *VARANUS ALBIGULARIS* Daud.*a.* Bulawayo, 3 Feb. 1908.*b.* Bulawayo, March 1909.

Found among rocks on granite kopjes and also on trees.

"Imbulu."

16. *VARANUS NILOTICUS* Linn.*a.* Bulawayo, April 1907.*b.* Yg. Bulawayo, 8 March, 1908.

Almost entirely aquatic.

"Uxamu."

17. *NUCRAS TESSELLATA* A. Smith.*a-c.* Bulawayo.18. *ICHNOTROPIS LONGIPES* Blgr.*a.* Bulawayo, 28 Sept. 1907.*b.* Khami River, Oct. 1907.19. *GERRHOSAURUS VALIDUS* A. Smith.*a.* Mt. Silozi, Matopos, April 1908.*b.* Empandene, Aug. 1908.

Lives among rocks on granite kopjes.

"Isiquisa."

20. *GERRHOSAURUS FLAVIGULARIS* Wiegman.*a-e.* Bulawayo.*f.* Empandene.

Fairly common, may be seen running about the ground among the grass during the warm part of the day.

"Isiquisa."

21. *MABUIA QUINQUETENIATA* Licht.*a, b.* Hellenvale Farm, near Bulawayo.*c.* Khami River, Oct. 1907.*d-g.* Colleen Bawn Mine, Gwanda Dist., Dec. 1908.*h.* Empandene.

Commonly found among boulders of granite kopjes.

22. *MABUIA VARIA* Peters.*a.* Khami River, Oct. 1907.*b, c.* Colleen Bawn Mine, Gwanda Dist., Dec. 1908.*d.* Empandene.

Found only on the rocks and on granite kopjes.

23. *MABUIA STRIATA* Peters.*a-d.* Bulawayo.*e, f.* Rhodes' Park, Matopos, April 1908.

Usually seen on the walls of buildings, in the sun, catching flies. Very common at Bulawayo.

"Umbankwa."

24. *LYGOSOMA SUNDEVALLI* A. Smith.*a.* Bulawayo, 13 Sept. 1907.

## RHIPTOGLOSSA.

25. *CHAMÆLEON DILEPIS* Leach.25 A. *CHAMÆLEON QUILENSIS* Bocage (*parvilobus* Blgr.).

Common, though not often seen on account of their assimilative coloration to the surroundings.

"Unwabu."



## OPHIDIA.

26. *TYPHLOPS DELALANDII* D. & B.

*a, b.* Bulawayo, 20 Oct. 1907.

27. *TYPHLOPS MUCRUSO* Peters.

*a, b.* Bulawayo.

*c, d.* Matopos.

Var. *VARIUS*.

*e-l.* Bulawayo.

Both varieties are very common at Bulawayo.

"Inyorka umshlaba."

28. *GLAUCONIA SCUTIFRONS* Peters.

*a-h.* Bulawayo.

"Insunula."

29. *PYTHON SEBÆ* Gmel.

*a.* Fort Usher, Matopos.

*b.* Springvale Farm, 16 miles S.E. of Bulawayo.

*c.* Syringa.

Commonly found in the hilly country.

"Inshlatu."

30. *BOODON LINEATUS* D. & B.

*a-m.* Bulawayo.

*n.* Shangani River, Nov. 1907.

*o.* Gwamayaya River, Nov. 1907.

31. *LYCOPHIDIUM CAPENSE* A. Smith.

*a-c.* Bulawayo.

*d.* Metetsi.

The Bulawayo examples represent form A of the British Museum Catalogue, while the specimen from Metetsi agrees with B.

32. *SIMOCEPHALUS CAPENSIS* A. Smith.

*a.* Bulawayo, 13 Dec. 1907.

*b.* Filabusi.

"Inyanda izulu."

33. *PSEUDASPIS CANA* Linn.

*a.* Yg. Bulawayo, Jan. 1908.

34. *CHLOROPHIS IRREGULARIS* Leach.

*a.* Victoria Falls, 16 Sept. 1908.

35. *DASYPELTIS SCABRA* Linn.

*a, b.* Bulawayo.

36. *TARBOPHIS SEMIANNULATUS* A. Smith.

*a.* Bulawayo.

37. *LEPTODIRA HOTAMBŒIA* Laur.

*a.* Mazeppa Mine, Gwanda, 1 Nov. 1907.

38. *TRIMERORHINUS TRITÆNIATUS* Gthr.

*a-k.* Bulawayo.

Fairly common in the neighbourhood of Bulawayo.

"Umshlwazi."

39. *PSAMMOPHIS SUBTÆNIATUS* Peters.

*a.* Bulawayo, 18 Sept. 1907.

*b.* Railway Terminus, Matopos, 6 July, 1907.

The latter was caught in the act of swallowing a lizard (*Agama* sp.).

40. *PSAMMOPHIS SIBILANS* Linn.

*a, b.* Bulawayo, 5 Aug. 1908.

*c.* Swena's, Gwamayaya River, 23 Nov. 1907.

*d.* Near Gwamayaya River, 24 Nov. 1907.

41. *THELOTORNIS KIRTLANDII* Hallow.

*a.* Bulawayo, 21 May, 1907.

*b.* Khami River, 21 April, 1900.

*c, d.* Empandene, Aug. 1908.

"Ukotikoti."

These specimens seem to combine characters of divisions A and B of the Brit. Mus. Catalogue, having the heads distinctly marked and the black blotches on the necks present.

42. *DISPHOLIDUS TYPUS* A. Smith.

*a-e.* Bulawayo.

"Indlondlo."

43. *APARALLACTUS CAPENSIS* A. Smith.

*a.* Bulawayo.

44. *ELAPECHIS GUENTHERI* Bocage.

*a.* Bulawayo.

*b.* Deka, about 50 miles south of Victoria Falls.

45. *NAIA HAIE* Linn.

*a-b.* Bulawayo.

*c.* Springvale Farm.

*d.* Railway Terminus, Matopos.

Blackish-brown examples, "C" of the Brit. Mus. Catalogue, are by far the most common, and the natives call them "Imamba." This name is used by the Zulus for *Dendraspis*

*angusticeps* and it is evident that the Matabele, who are of Zulu descent and migrated from Zululand some 50 years ago, have mistaken the dark variety of *Naie haie* for that species.

Var. ANNULIFERA, Peters.

*e.* Bulawayo.

*f* (portion of skin). 15 miles south of Bulawayo.

"Ilunga."

46. NAIA NIGRICOLLIS Reinh.

*a-c.* Bulawayo.

*d.* Mazeppa Mine, Gwanda.

*e, f.* Deka.

I know of several instances here of this species spitting at people who have attacked it.

"Ipimpi."

47. ASPIDELAPS SCUTATUS A. Smith.

*a.* Empandene, Aug. 1908.

48. CAUSUS DEFILIPPII Jan.

*a.* Bulawayo, 9 Dec. 1907.

49. BITIS ARIETANS Merr.

*a.* Bulawayo.

Very common.

"Ibululu."

50. BITIS CAUDALIS A. Smith.

*a, b.* Bulawayo.

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May 25, 1909.

Dr. S. F. HARMER, M.A., F.R.S., Vice-President,  
in the Chair.

The Secretary read the following report on the additions made to the Society's Menagerie during the month of April 1909:—

The number of registered additions to the Society's Menagerie during the month of April last was 243. Of these 116 were acquired by presentation, 15 by purchase, 91 were received on deposit, 6 in exchange, and 15 were born in the Gardens.

The number of departures during the same period, by death and removals, was 161.

Amongst the additions special attention may be directed to :—

One Burchell's Zebra (*Equus burchelli*) ♂, from S. Africa, presented by F. A. R. Zurcher, Esq., on April 1st.

One Eland (*Taurotragus oryx*) ♂, born in the Menagerie on April 3rd.

One Cape Ant-bear (*Orycteropus capensis*), from S. Africa, purchased on April 17th.

One Black-fronted Bulbul (*Pycnonotus nigricans*); one Red-capped Lark (*Tephrocorys cinerea*), presented; and two Levillant's Barbets (*Trachyphonus cafer*), new to the Collection, one Martial Hawk-Eagle (*Spizaetus bellicosus*), deposited with other S. African Birds by Major Boyd Horsbrugh, F.Z.S., on April 15th.

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Mr. J. Lewis Bonhote exhibited an example of a tetragen duck, which he had bred in his Aviaries, containing Wild Duck (*Anas boschas*), Spotbill (*Anas pœcilorhyncha*), Australian Duck (*Anas superciliosa*), and Pintail (*Dafila acuta*). This bird was of the  $F_2$  generation, i. e., it had been bred from brother and sister and was remarkable in that, to all outward appearances, it was almost indistinguishable from a pure bred Wild Mallard. According to Mendel's Law it was to be expected in theory that such a bird should appear, but in practice the chance of all the Mallard characters appearing in any one individual was very remote, and the fact that they had all appeared in this bird was a striking confirmation of the truth of Mendel's Law even in a very complicated case.

The only difference to be noted between this bird and the pure-bred Mallard was the rather more defined and Pintail-like vermiculations to the flank-feathers.

Mr. Bonhote also exhibited a pair of pentagens of the  $F_2$  generation. These contained the blood of the following species: *Anas boschas*, *A. pœcilorhyncha*, *A. superciliosa*, *A. melleri*, and *Dafila acuta*. As yet they showed no tendency to infertility, but on the contrary proved more fertile than several less complicated crosses. The matter had become too much involved to draw any deductions from their plumage, but it would be noticed that the Mallard seemed to predominate. They were interesting, however, as showing to what extent cross-breeding could be carried among certain species, the hybrids proving fertile to at least the 4th generation since the last cross with a pure species.

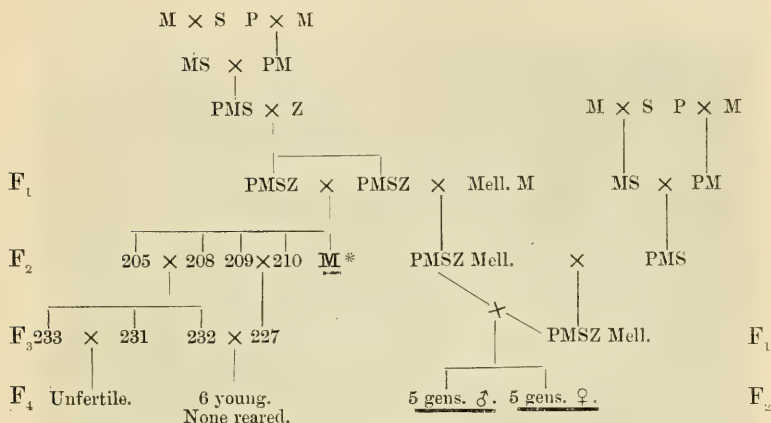
Many hybrids, as was well known, were unfertile, but with those that proved fertile in the first generation, infertility was generally reached in the 3rd generation ( $F_3$ )—that is to say the 3rd generation from the last cross with a pure species; in some cases,



however, the  $F_3$  generation proved fertile, but as yet no young of the  $F_4$  generation had been reared.

Infertility was usually accompanied by loss of colour.

*Pedigree of birds exhibited.*



\* Apparently.

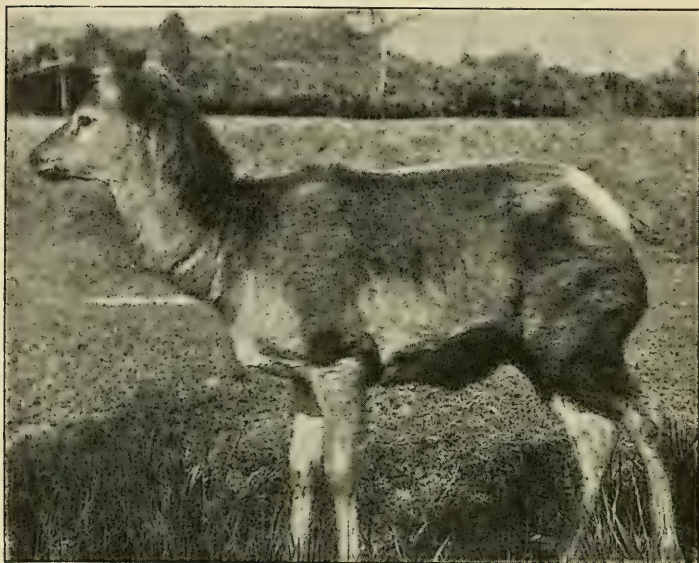
(Those underlined were the specimens exhibited.)

Mr. L. Harding Cox, F.Z.S., exhibited a living specimen of the Amblystome or transformed Axolotl, and drew attention to the following distinguishing points of the terrestrial batrachian, viz.: alteration in dentition, possession of lungs and eyelids, absence of gills and crest, and variation in colour.

Mr. Lydekker exhibited the photograph (text-fig. 182, p. 600) of a young Stag from Sikhim, now living in Nepal, which had been lent by Mr. David Ezra. This photograph Mr. Lydekker believed to represent the Shou (*Cervus affinis*); and if so, it was the first picture of that deer which had been submitted to the Society since Brian Hodgson's time. The stag depicted is noticeable on account of its large ears, thick mane, large rump-patch, and rather short, thin tail. It is in winter coat; and the general colour is approximately the same dark brown as that of the Hangul (*C. cashmirianus*), while the rump-patch is white, as in the latter. In the large size of this rump-patch, as well as in the big ears, the Sikhim deer is, however, decidedly Wapiti-like.

The photograph agrees fairly with a picture of a young stag in Hodgson's sketches, which is probably also in the winter coat. A sketch of a stag in the same series is redder, with no distinct rump-patch, and may represent the summer coat.

Text-fig. 182.



Young Shou Stag, from a photograph lent by Mr. D. Ezra.

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The following papers were read :—

1. On the Skull-Characters in the Southern Sea-Elephant.

By R. LYDEKKER \*.

[Received May 15, 1909.]

(Text-figures 183–185.)

The distribution of the Southern Sea-elephant (for which, following Sir W. H. Flower †, I retain the name *Macrorhinus leoninus*, despite the objection that may be raised against the origin of the generic designation) suggests the existence of several local races. The species occurs, for instance, on the island of San Juan off the coast of Chile, and in the Falklands; and it is quite

\* Communicated by permission of the Trustees of the British Museum.

† Proc. Zool. Soc. 1881, pp. 145 *et seqq.*

conceivable that the same race may inhabit these two localities. On the other hand, it is scarcely likely that Elephant-seals would migrate from the Falklands to Tristan d'Acunha on the African side of the South Atlantic; and it is therefore probable that the representatives of the species from the latter island are racially distinct. The same remark will apply to the Elephant-seals of the Kerguelen, Crozet, and Heard groups in the south of the Indian Ocean; while yet another race is probably represented by those inhabiting the Macquarie and Chatham groups in the New Zealand seas.

The idea that there may be several local forms of Sea-elephant is by no means new. It was adopted, for instance, by Dr. J. E. Gray on page 180 of the fifth volume of "Griffith's Cuvier," 1827; the Macquarie Island form being designated *M. proboscidea*, while the name *Macrorhina patagonica* was proposed for the Falkland race, and Desmarest's titles *ansoni* and *byroni* were used respectively for the Sea-elephants from Juan Fernandez and the Tinian Islands, the latter being in the Ladrone group, north of Australia. Again, in the *Monatsbericht* of the Berlin Academy for 1875, p. 395, Dr. Karl Peters proposed the name *falclandica* for the Falkland, and *kerguelensis* for the Kerguelen race.

As regards these various names, it may be mentioned that the *Phoca leonina* of Linnæus is based on a specimen brought from Juan Fernandez by Lord Anson in 1744, which was exhibited for many years in the British Museum. All that now remains of this type-specimen is the anterior portion of the jaws, which is preserved in the Museum of the Royal College of Surgeons, where it was transferred in 1809\*. The specimen is too incomplete to give any idea of the distinctive skull-characters of the typical Juan Fernandez race.

Of this race, namely *M. leoninus typicus*, Peron's *Phoca proboscidea* and Desmarest's *ansoni* are synonyms.

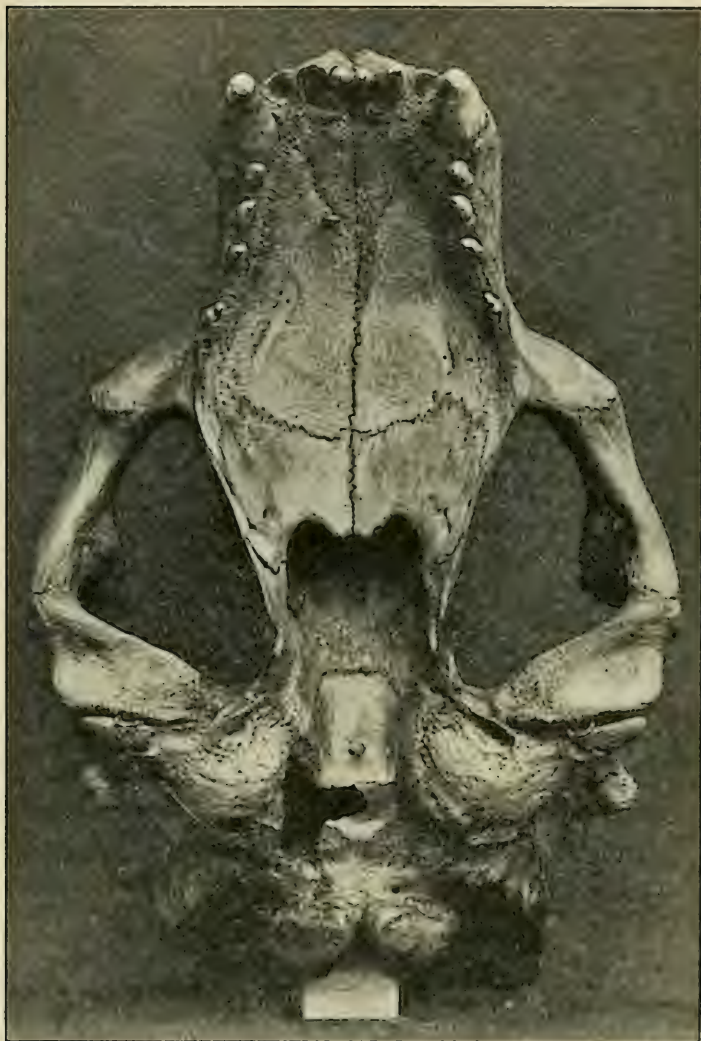
With regard to Gray's *patagonica*, this was founded on a young skull figured by F. Cuvier†, which is stated by Gray to be convex with the brain-cavity more extended and the nasal region shorter than in "*M. peronii*," while the cutting-teeth number only  $\frac{4}{2}$ . This, owing to the immaturity of the type, I regard as an insufficient description. On the other hand, the *falclandica* of Peters, based on the specimen figured in Pernetty's "Histoire d'un Voyage aux Isles Malouines, fait en 1763 et 1764, avec des Observations sur le Détroit de Magellan et sur les Patagons," appears to be valid; and the name *M. l. falclandica* is therefore available for the Falkland Sea-elephant, if this be distinct from the typical race. The *M. kerguelensis* of Peters cannot be regarded as more than a *nomen nudum*, and the same is the case with Desmarest's *P. byroni*, even if an Elephant-seal occurs in the Ladrone. There is also the *Phoca elephantina* of Molina, but

\* See Flower and Garson, "Cat. Osteol. Specimens, Mus. R. Coll. Surgeons," pt. 2, p. 217.

† Mém. Mus. Paris, iv. pl. xiv. fig. 2.

this evidently relates to the Chilian species subsequently described as *M. angustirostris*.

Text-fig. 183.



Palatal aspect of skull of Male Falkland Sea-Elephant. About  $\frac{1}{4}$  nat. size.  
From specimen in Museum of R. College of Surgeons.

After this much of introduction, I turn to the proper subject of this communication, which relates to skulls of the southern Sea-



elephant now in the British Museum. These include two males from Macquarie Island presented by the Hon. Walter Rothschild, a male from Chatham Island obtained by Professor H. O. Forbes, a female from the "Antarctic Seas" obtained during the voyage of the 'Erebus' and the 'Terror,' and a male from the Crozet group. With these, by the courtesy of Dr. A. Keith, I have been able to compare an old male skull from the Falklands preserved in the Museum of the Royal College of Surgeons, being the one on which the above-mentioned paper by Sir W. H. Flower is based.

In comparing these skulls I find that the most satisfactory distinctive characters are afforded by the palatal surface, and it is to this aspect that attention will be chiefly restricted.

Great difference obtains in regard to the proportions of the length to the width of the skull in the different local forms, as is shown in the following table:—

	Falkland.	Macquarie.	Crozet.	Chatham.
Basal length .....	20 ins.	18 ins.	16.5 ins.	16.3 ins.
Maximum width ...	15	14	14	11.7
Length of palate ...	11	9.5	9	8.5
Width of do. ...	7.3	6.3	6.5	6.1

Taking first the Falkland race, which, as already mentioned, may be identical with *M. l. typicus*, but which it will be convenient to call *M. l. falklandicus*, the skull (text-fig. 183) is characterised by its relative length and narrowness. The palate is also long and narrow, nearly flat in the palatine region, but becoming suddenly hollowed on the line between the 4th and 5th cheek-teeth. The palatines themselves form a long median suture; the process of the pterygoid is small; and the premaxillæ are long, and V-shaped. As additional features may be mentioned the relative narrowness of the condyles, and the circumstance that the lower border of the anterior zygomatic root projects considerably behind the posterior aperture of the maxillary foramen.

A second skull in the Museum of the Royal College of Surgeons from the Falklands agrees in essential characters with the above.

Turning to the two Macquarie skulls, which are practically identical, we find the general proportions not very different from those of the Falkland specimen, but the palate (text-fig. 184, p. 604) is much more hollowed\*, and this throughout its whole extent. Then, again, the inter-palatine suture is shorter and the pterygoid process much larger; while the condyles are wider, and the lower border of the anterior zygomatic roof does not project behind the hind aperture of the maxillary foramen.

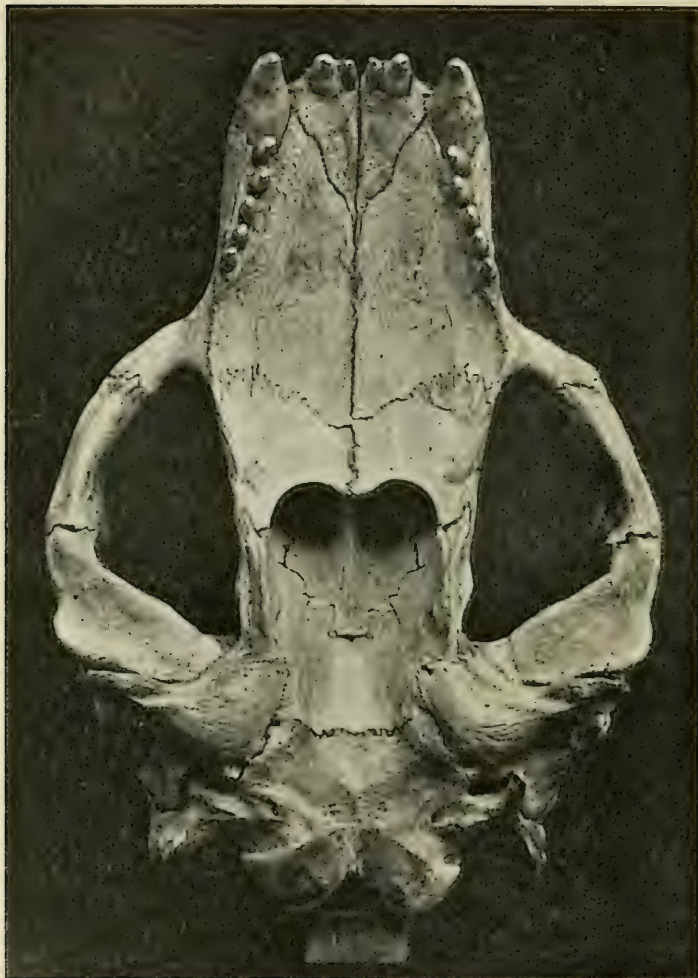
For the Macquarie race, as typified by the figured skull (B. M. No. 1.6.22.1), I propose the name *M. l. macquariensis*.

The natural supposition would be that the Sea-elephant from the Chatham Islands would be identical with the one inhabiting the Macquaries; and this appears to be borne out by a skull of

\* I use the term hollowed in place of vaulted as being more convenient.

the former in the British Museum (No. 94.11.17.1), which is that of a young male. Its dimensions are given in the fourth column of the table. This skull agrees in general characters with the two

Text-fig. 184.

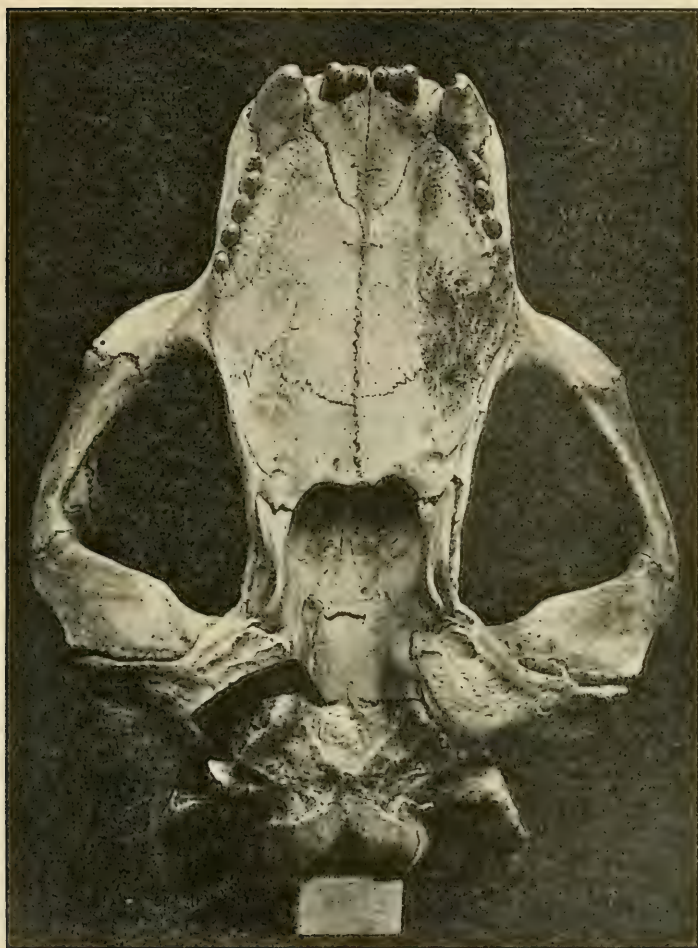


Palatal aspect of skull of Male Macquarie Sea-Elephant. About  $\frac{1}{3}$  nat. size.  
From a specimen in the British Museum.

Macquarie specimens, but differs by the much less deep incision of the central portion of the supraoccipital. Since, however, this is

a feature which may apparently be due to immaturity, I associate the specimen with the Macquarie race.

Text-fig. 185.



Palatal aspect of skull of Male Crozet Sea-Elephant. About  $\frac{1}{4}$  nat. size.  
From a specimen in the British Museum.

Coming to the Crozet skull (text-fig. 185), this is shown by the table of measurements to be broadly distinguished from the two preceding races by its shortness and width; the maximum zygomatic width being equal to that of the skull of the Macquarie race which is  $1\frac{1}{2}$  inch longer, while the palatal width of the Crozet

actually exceeds that of the Macquarie skull. To this difference may be added the almost complete flatness of the palate, the longer inter-palatine suture, the much more slender pterygoid process, the U-shaped palatal aspect of the premaxillæ, and the extremely narrow condyles.

For this race as typified by the figured skull I suggest the name *M. l. crosetensis*, of which Peters' undefined *M. kerguelensis* is probably a synonym. The immature 'Erebus' and 'Terror' skull, said to be that of a female, may belong to this race; the greater prominence of the tympanic region as compared with the Crozet specimen, being not improbably a feature due to immaturity.

As the result of the foregoing comparisons, our information with regard to local races of the Southern Sea-elephant, as definable from skull-characters (and, with the present material, I can find no others of any value), may be summarised as follows:—

1. *Macrorhinus leoninus typicus*. Juan Fernandez.

Skull unknown.

2. *M. l. falclandicus*. Falkland Islands. Perhaps inseparable from typical race.

Skull long and narrow; palate flat behind and hollowed in front; palatine suture long; pterygoid process small; palatal aspect of premaxilla V-shaped.

3. *M. l. macquariensis*. Macquarie and (?) Chatham Islands.

Skull of the same general type as in the preceding, but the palate markedly hollow throughout, the palatine suture shorter, and the pterygoid process longer. Condyles wide.

4. *M. crosetensis*. Crozet and (?) Kerguelen and Heard Islands.

Skull short and wide, with the palate almost flat, the pterygoid process very slender, the premaxillæ U-shaped, and the condyles narrow. This race is said to be the largest of all.

In addition to these there may be a distinct race inhabiting Tristan d'Acunha. I know nothing of the Sea-elephants of the South Shetlands.

Although the Californian Sea-elephant (*M. angustirostris*) does not properly come within the purview of the present communication, I may take the opportunity of mentioning that the fore part of a skull at present in the British Museum shows such difference in the palatal region from all the races of the Southern form, that on this ground alone the Southern and the Northern Sea-elephants appear entitled to be regarded as specifically distinct.

[Since this paper was read Mr. Rothschild has informed me that he has evidence to show that the San Juan and Chilian Sea-elephants are identical, and that migration formerly took place between the San Juan and the Guadaloupe Island animals. If this be so, I presume *angustirostris* would be regarded as a synonym of *leoninus*, while *falclandicus* would become the substantive name for the Southern species.]



## 2. On the Skull of a Black Bear from Eastern Tibet, with a Note on the Formosan Bear. By R. LYDEKKER\*.

[Received May 1, 1909.]

(Text-figures 186 &amp; 187.)

On page 198 of the 'Fauna of British India: Mammalia,' Dr. Blanford states that the Himalayan Black Bear is unknown in Tibet; and it is for that reason he employed for the species the name *Ursus torquatus* instead of *U. tibetanus* (or *thibetanus*, as it is spelt by F. Cuvier).

The British Museum has, however, the skull of a female of this species from the mountains of Sze-chuen, which was collected by Berezowsky and obtained by exchange with the Tring Museum in 1896. This, of course, is no proof that the species occurs in Eastern Tibet itself, although it affords a strong presumption that such may be the case. Decisive evidence on this point is, however, afforded by the skull and skin of an old and presumably male bear of this species shot by Captain Malcolm McNeill, some distance to the westward of Ta-chien, in Eastern Tibet, which have been submitted to me for determination. The skull has been secured for the Museum. The skin, which is in winter coat, differs from that of any Himalayan specimens of *U. torquatus* that have since come under my notice—and I have handled a good many—by the greater length and softness of the hair. The skull (text-fig. 186 A, p. 608), as compared with a full-grown and probably male, but rather younger, Himalayan specimen of the same approximate length (text-fig. 186 B), is characterised by the much smaller size of the cheek-teeth, as will be apparent from the following measurements and the accompanying text-figures.

	Himalayan.	Tibetan.
Basal length of skull .....	10·15 ins.	9·9 ins.
Maximum zygomatic width of do. ..	6·5	6·7
Length of last 3 upper cheek-teeth ...	2·6	2·13
"    "    upper molar .....	1·3	0·98
Width    "    "    "    "    " .....	0·7	0·6
Length    "    "    3 lower cheek-teeth ...	2·7	2·18
"    "    "    lower molar .....	0·8	0·61
Width    "    "    "    "    " .....	0·6	0·42
Length of penultimate lower molar ...	0·9	0·8

In this table it will be noticed that the Tibetan skull is rather broader, both actually and proportionately, than the Himalayan specimen. As regards the cheek-teeth the most important feature,

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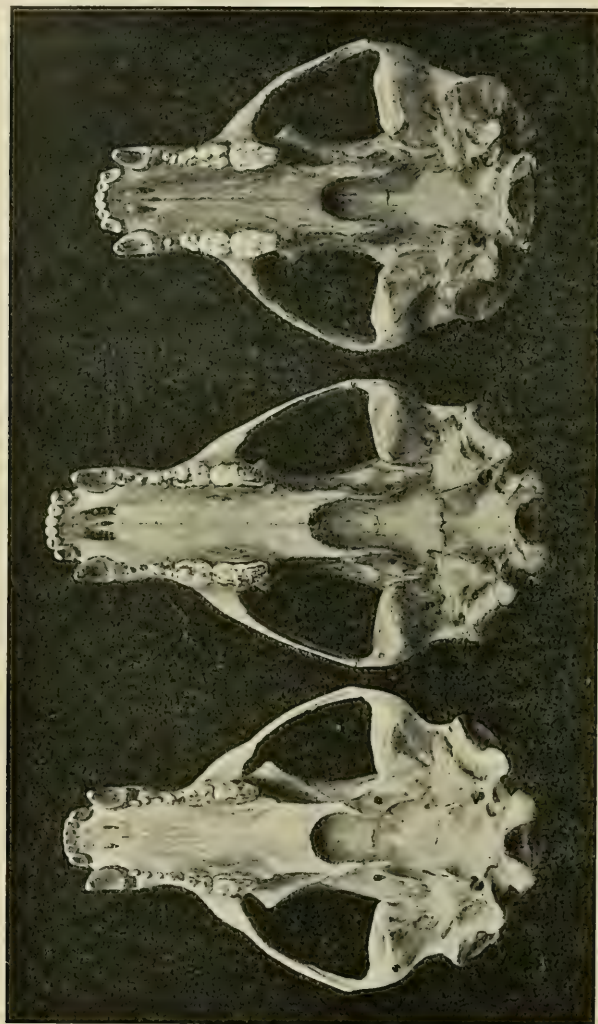
next to the conspicuously smaller size of the last three, is the narrower form of the third lower molar of the Tibetan skull which consequently, as shown in text-figure 187 A, appears to be both longer and narrower than the corresponding tooth in the Himalayan specimen.

Text-fig. 186.

C.

B.

A.



Palatal aspect of skulls of *Ursus torquatus* (A), *U. t. macneilli* (B), and *U. t. formosanus* (C). About  $\frac{1}{2}$  nat. size.

In the skull of a female Black Bear from Assam recently offered to the Museum the cheek-teeth are of practically the same size

as in the Tibetan specimen, but the palate is much wider, as is shown by the following measurements :—

	Tibet.	Assam.
Length of six upper cheek-teeth .....	3·9 ins.	3·9 ins.
„ last 3 upper cheek-teeth ...	2·1	2·0
Width of palate between <i>m</i> 2 .....	1·5	1·7

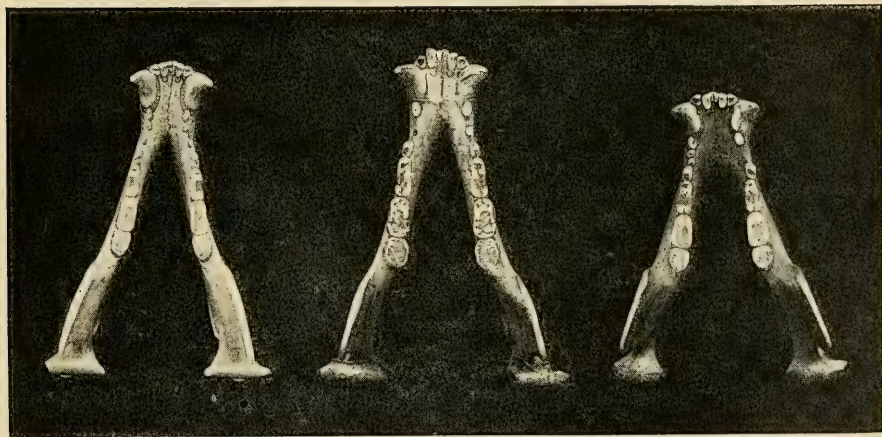
This relative narrowness of the palate in the Tibet skull is borne out by the above-mentioned female skull from Sze-chuen, in which the length of the space occupied by the last three cheek-teeth is 2·3 ins., while the palatal width between *m* 2 is only 1·25. As the Sze-chuen skull certainly belongs to the same race as the one from Tibet, and as its teeth are rather larger than those of the latter (in which the palatal width between *m* 2 is 1·55 inches), it indicates that the narrowness of the palate in the female is quite as important a feature of the Tibetan race as is the small size of the cheek-teeth and the relative narrowness of the third large molar in the male. In both sexes the palate is distinctly vaulted, whereas in the typical Himalayan race it is nearly flat.

Text-fig. 187.

A.

B.

C.

Palatal aspect of the lower jaws of the same three skulls. About  $\frac{1}{4}$  nat. size.

Letters as in text-fig. 186.

These features seem to justify the recognition of a distinct Tibetan race of *U. torquatus*, for which the designation *U. t. macneilli* will be appropriate, the male skull forming the subject of the present paper being the type.

Now that the Himalayan Black Bear has been shown to occur in Tibet and Sze-chuen, it might be argued that the time has come for the re-instatement of the name *tibetanus*; but since the typical



race is Himalayan, it appears to me that it will be best to follow Dr. Blanford's usage and retain the name *U. torquatus*. As I have on a previous occasion shown that the Bruang (*U. malayanus*) ranges into Sze-chuen \*, we have now evidence of the occurrence in that province of two species of Black Bears.

Before concluding, I may refer to the type skull of *U. formosanus* of Swinhoe †, which is contained in the British Museum Collection (No. 70.2.10.9). That this skull indicates a bear specifically identical with *U. torquatus* appears to me indisputable—in the sense in which I regard species. At the same time, it is so much wider and shorter than the skull of *U. torquatus typicus* that it must, without hesitation, be regarded as representing a distinct race, with the designation *U. t. formosanus*. This will be apparent from the following measurements:—

	<i>typicus.</i>	<i>formosanus.</i>
Basal length of skull .....	10.15 ins.	9.1 ins.
Maximum zygomatic width of do. ...	6.5	6.95
Length of last 3 upper cheek-teeth ...	2.6	2.25

The Formosan skull (text-fig. 186, C) is distinguished, moreover, by the absence of any distinct bevelling away of the outer side of the talon of the last cheek-tooth, which in consequence has nearly parallel sides. The last lower molar (text-fig. 187, C) is broad and short, so that it appears more rounded than the corresponding tooth of *typicus*, and thus very different from that of *macneilli*. In its shortened and wider form the skull of *U. t. formosanus* makes a slight approximation to that of *U. malayanus*, which, however, is broadly distinguished by its still greater expansion, the excessive size of the palate, and the smaller cheek-teeth, more especially the last.

### 3. The Anatomy of the Olfactory Organ of Teleostean Fishes.

By R. H. BURNE, M.A., F.Z.S.

[Received May 10, 1909.]

(Text-figures 188–213.)

The coarse anatomy of the olfactory organ in the Teleostean Fishes seems to have received too little attention. Reference to the leading old and modern text-books (Milne-Edwards, Owen, Günther, Cambridge Natural History, Parker and Haswell, Wiedersheim, Gegenbaur, &c.) leaves the general impression that apart from a few isolated cases, the organ is remarkably constant and consists of a pair of simple concavities upon the fore-part of the face opening to the exterior by a pair of nostrils and each containing a group of olfactory laminae arranged rosette-wise

\* *Vide* P. Z. S. 1906, p. 907.

† *Ibid.* 1864, p. 380.



above the termination of the olfactory nerve, such variation as occurs being mainly confined to details of the nostrils.

Although this impression is no doubt in part due to the natural tendency of text-books to lay too great stress upon the condition found in the usual teaching type which in this case is generally a Gadid, a study of the original papers dealing with this particular organ shows that the work done upon it has been neither large in amount nor particularly extensive in scope.

The following is, I think, a fair statement of the present state of our knowledge of the coarse anatomy of the Teleostean Nose, and of the chief sources from which it is derived :—

- Owen\* and Milne-Edwards† mention that in the Mackerel and *Anarrhichas* there are certain accessory nasal sacs in connection with the true olfactory chamber which act as compressible reservoirs by means of which, as in the case of the pituitary cæcum of the Lamprey, a current of water is driven through the olfactory chamber by the movements of the jaws and opercula in respiration.
1876. Sophie Pereyaslawzeff‡ published a preliminary paper on the olfactory organ of Fishes, and in it described in detail the coarse and fine anatomy of *Solea impar* and *Lophius piscatorius*. The full paper seems never to have appeared—a matter for regret, for from the list of genera and species mentioned in the preliminary paper as the material upon which the work was done, it would evidently have been a valuable contribution to the subject.
1884. Blau§ in a most important paper on the olfactory membrane in Fishes and Amphibia gives short descriptions of the coarse anatomy of the olfactory pit and rosette in several species of Teleostei. The descriptions so far as they go are good, but as they are incidental to the true subject of the paper and only deal with the anatomy so far as it is necessary for the purpose in hand, they are naturally imperfect. However, in this paper there is a certain amount of information upon the form of the olfactory chamber and rosette in *Belone*, *Exocoëtus*, *Trigla*, *Esox*, *Umbra*, *Cottus*, *Gobius*, *Gadus*.
1887. Wiedersheim|| writes a full and interesting account of a series of stages in the degeneration of the olfactory organ of Plectognaths, tracing its transformation from a simple concavity of the normal type to the condition of a split tentacle in which the olfactory membrane is fully exposed. The species described are *Tetrodon*

\* Anat. Vertebrates, vol. i. p. 329.

† Leçons sur la Physiol. T. xi. 1874, p. 475.

‡ Inaug.-dissert. Zürich, 1876.

§ Arch. f. Anat. 1884, p. 241.

|| Festschrift v. Kölliker, 1887, p. 73.

*nigropunctatus*, *T. immaculatus*, *T. papua*, *T. pardalis*, and *Diodon maculatus*.

The same subject has been treated by Tate Regan (Proc. Zool. Soc. 1902, vol. ii. p. 292).

1889. Bateson \* in a paper on the sense-organs and senses of Fishes, besides some highly interesting physiological notes which will be referred to more fully later on, gives details of the structure of the nostrils and olfactory rosette in various common species of Fishes, pointing out (1) the tubular character of the anterior nostril in the few fishes that hunt their food by scent (*Motella*, *Cobitis*, *Solea*, *Conger*, *Anguilla*, *Lepidogaster*), (2) the valvular mechanism of the posterior nostril in certain Flat-fishes, (3) the main types of structure of the rosette—elongated (Eels), oval (the majority of Fishes), or circular (*Cottus*), and an exceptional type in which the leaflets are arranged in parallel series in a single row (*Pleuronectes*, *Hippoglossus*).

1894. Solger † briefly describes the olfactory chamber of the Stickleback, stating that the nostril (as in many Pharyngognaths) is single and that the olfactory chamber proper is extended downwards to the buccal membrane by an accessory sac lined with indifferent epithelium and by its alternate expansion and contraction synchronously with the respiratory movements causing water to flow in and out of the true olfactory part of the cavity.

1899. Kyle ‡ describes in several species of Pleuronectids (*Hippoglossus*, *Pleuronectes*, *Rhombus*, *Solea*, *Cynoglossus*) accessory nasal sacs in connection with the true olfactory chamber and lays stress on the fact that in these Fishes, with the exception of *Solea* and *Cynoglossus*, the sacs secrete mucus and are not simple reservoirs for producing water-currents by their alternate expansion and contraction. He mentions, however, (but without description) that such simple reservoir sacs do occur in several other families (Blenniidae, one sac; Labridae, one sac; Scorpaenidae, two sacs), and concludes generally that accessory sacs are confined to semi-sedentary as opposed to migratory Fishes.

He further describes, and this forms an important part of the paper, a direct and apparently normal connection between the accessory sacs and the mouth in a single specimen of *Cynoglossus*.

In addition to the above papers which deal entirely or mainly with the nose, descriptions of this organ in isolated genera are

\* Journ. Marine Biol. Ass. vol. i. 1889, p. 229.

† Zeits. Wiss. Zool. Bd. lvii. 1894, p. 186.

‡ Journ. Linn. Soc. vol. xxvii. 1899, p. 541

probably to be found scattered about in monographs, dealing with special genera. The only one, however, to which I am able to refer is the detailed description of the olfactory organ of the Plaice by Cole and Johnston\*.

Some few years ago when a Catalogue of the Sense-organs in the Museum of the College of Surgeons was in preparation, my attention was directed to this subject of the anatomy of the Fish nose, and from the few dissections then made it soon became apparent that variations upon the fundamental ground plan are far more numerous and general than the ordinary sources of information would lead one to suppose. Since then I have collected notes upon this subject, as occasion offered, and in doing so have kept four main objects in view:—

- (1) To see how far the fundamental part of the olfactory organ (a concavity in the face, containing an olfactory rosette) is constant in its form and in its position relative to the bones of the skull.
- (2) To see how far the variations observed accord in their occurrence with authoritative systems of classification and so are to be regarded as of taxonomic importance.
- (3) To explain so far as possible the action of such variations of structure as appear to be of functional importance.
- (4) To see if any connection can be traced between variations in the nose and the general habits of the Fish.

The Fishes dissected belong to 32 families and 51 genera, representing to some degree most of the larger divisions of the order. They are mostly the common Fishes of the market, supplemented by some exotic forms from the College stores, for the identification of which I am much indebted to Mr. Boulenger, F.R.S. In the following descriptions the Fishes have been arranged in order according to Boulenger's system in the Cambridge Natural History, with the exception of the Anacanthini which have been taken first, out of their proper place in order that the simple unspecialised nose of the Haddock may serve as a standard of comparison for the rest.

#### ANACANTHINI.

##### GADIDÆ.

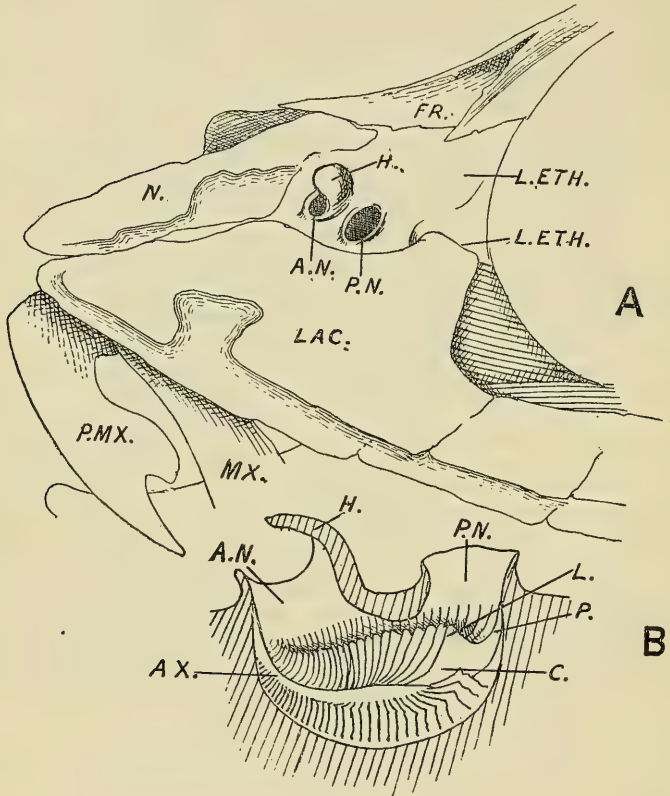
*Gadus aeglefinus* (text-figs. 188 & 189).

The nostrils (text-fig. 188, A, p. 614) lie in front of the orbit in an area of soft skin bounded above by the nasal and frontal bones and below by the lachrymal. A line passing through both slopes from in front downwards and backwards at an angle of about 45° to the horizontal. The anterior nostril is circular and bordered by a low tubular lip elevated posteriorly to form a hood-like flap, by which in forward progression water would be deflected

\* L. M. B. C. Memoirs, No. viii. Pleuronectes. 1901.

into the nostril. The posterior nostril is larger than the anterior and of more oval shape; it is bordered by a low lip. Between the two is a narrow bridge of skin. The nostrils open into either end of a pit (olfactory chamber) which is oval in surface-view but semicircular in vertical section (text-fig. 188, B). The cavity of the pit is almost completely filled by a series of leaflets (the

Text-fig. 188\*.

*Gadus aeglefinus.*

- A. The relation of the nostrils to the superficial bones of the face.  
 B. Diagram of olfactory chamber in longitudinal section.

olfactory laminae) arranged radially along the sides and posterior end of a linear axis which in front is attached to the anterior lip of the anterior nostril. The laminae are attached to the axis and to the floor and a considerable extent of the side walls of the olfactory

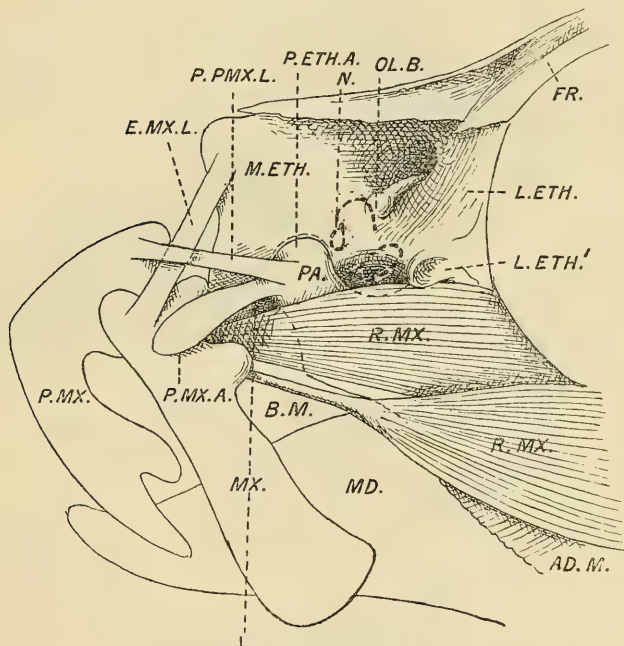
\* For explanation of abbreviations in the text-figures see p. 663.



chamber. The free edge of each is produced in the middle (as in Elasmobranchs) to form a "linguiform process" and can thus be conveniently divided into mesial, central, and peripheral segments.

Beyond the area covered by the rosette the lining membrane of the chamber is smooth. The epithelial wall of the olfactory chamber is separated by a layer of loose connective tissue from an outer dense fibrous capsule continuous with the general subdermal tissue of the head, the whole being to a considerable extent surrounded by lymph spaces. The entire organ lies in a hollow in the ethmoid (text-fig. 189) just above and behind the ethmo-palatine articulation and is in no direct relation with either the buccal membrane, jaws, or jaw muscles.

Text-fig. 189.



*Gadus aeglefinus.*

The relation of the nostrils to the deeper bones of the face.

The olfactory tract passes through the skull by a foramen in the lateral ethmoid below the anterior end of the frontal scute and at once joins the olfactory bulb which is connected to the deep surface of the rosette by short nerves.

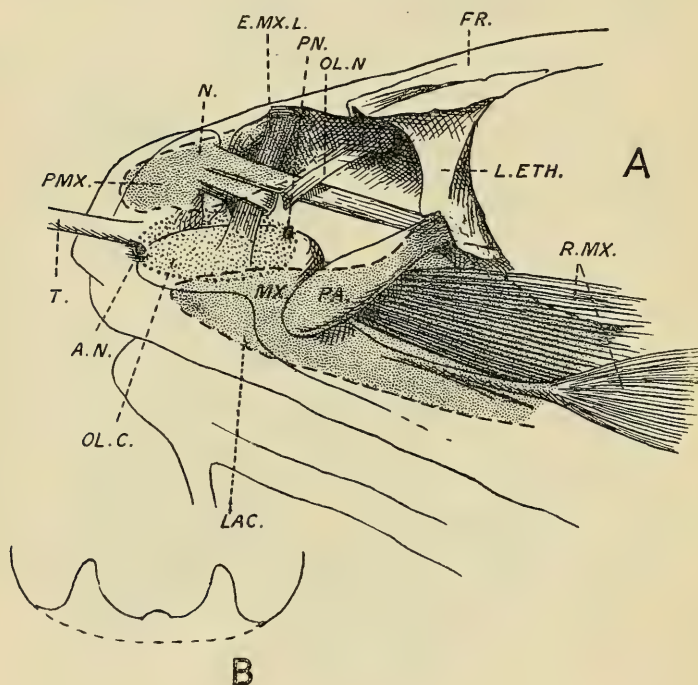
In the Cod (*Gadus morrhua*), Bib (*G. luscus*), and Whiting

(*G. merlangus*), the olfactory organ differs only in minute details from that of the Haddock. For instance, in the Whiting the nostrils are relatively further apart and smaller, and the flap upon the hinder edge of the anterior nostril is not quite so high.

*Motella tricirrata*.

The olfactory organ, though formed upon the same plan as in the above described Gadids, differs in the following particulars:—The nostrils are relatively smaller, more widely separated and situated nearer the extremity of the snout, the anterior being not

Text-fig. 190.



*Motella tricirrata*.

- A. Shape and position of the olfactory chamber.  
B. Diagram of cross section of the rosette.

far removed from the upper lip. The valvular posterior border of the anterior nostril is modified to form a long tentacle, a circumstance that no doubt partly explains the forward position of the nostril. The olfactory chamber and rosette have a long oval form in agreement with the greater distance between the nostrils. The peripheral segments of the leaflets of the rosette

are but slightly developed, leaving smooth an appreciable area of the floor of the olfactory chamber around the rosette.

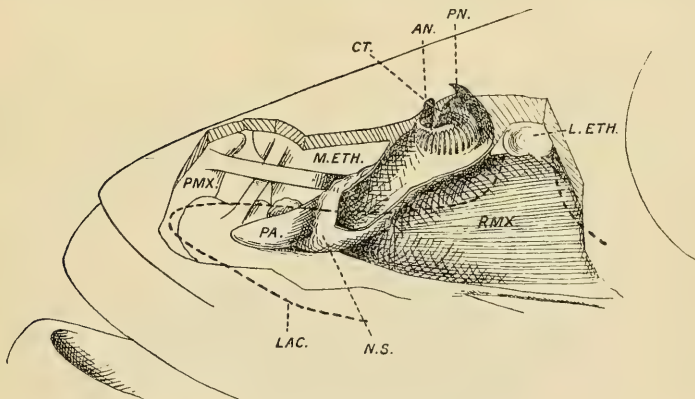
The relations of the olfactory chamber to the skull are also peculiar (text-fig. 190). It lies above the head of the maxilla, and is thus far in advance of its usual position in the hollow of the ethmoid, although the foramen in which the olfactory bulb lies perforates the lateral ethmoid at the usual spot. An olfactory nerve of unusual length is in consequence interposed between the bulb and the rosette\*.

The abnormal position of the olfactory chamber may be partly explained, as suggested above, by the fact that the tentacle developed in connection with the anterior nostril would be most advantageously placed near the extremity of the snout, but it is also in part due to a shortening of the skull between the orbit and the maxillary process of the palatine.

*Merluccius vulgaris.*

The nostrils occupy much the same position as in the Haddock, but are set quite close together, like those of the Salmonidæ, which in fact they closely resemble. The anterior nostril is circular, the

Text-fig. 191.



*Merluccius vulgaris.*

Position of olfactory chamber and nasal sac.

posterior nostril crescentic and embracing the anterior with its concavity; both are wide open. There is no upstanding flap upon the hinder margin of the anterior nostril, but the integument between the two is prolonged into the cavity of the olfactory chamber, forming a curtain (as in the Salmonidæ) to conduct water

\* It may be noted that here, and in all other cases observed, the olfactory nerve is very considerably larger than the tract by which the bulb is connected to the brain.

entering through the anterior nostril into the heart of the rosette.

The olfactory chamber occupies a similar position relative to the bones of the skull, as in the Haddock, but slightly lower down, so that its lower border rests upon the retractor of the maxilla (text-fig. 191, p. 617). Its anterior part, ventral to the rosette, is produced forward to form an accessory sac that passing forward deep to the dorsal parts of the lachrymal bone dips beneath the maxillary process of the palatine into the space included between this bone, the head of the maxilla, and the vomer.

The cavity of the olfactory chamber and accessory nasal sac was filled with an unusually large amount of mucus. Apart from a mucus-secreting function, it seems highly probable from its position that this nasal sac would act as an aspirator bulb, being compressed both by the movements of the head of the maxilla and by the swelling of the jaw muscles upon and near which it lies. This action must, however, be slight at the best, for no bubbles escaped from the nostrils when the jaws were forcibly closed under water.

The rosette is circular and is composed of about 28 laminæ, each of which is transversely pleated and has a claw-like outline due apparently to an exaggeration of the linguiform process and the almost complete suppression of the peripheral segment.

### *Summary.*

In the Anacanthini examined (Gadidæ) the olfactory organ is of a simple type and shows great uniformity. It is, in brief, a hemispherical depression, opening to the exterior by two nostrils and containing a rosette of laminæ for the lodgement of the olfactory epithelium through which a current of water is deflected during forward locomotion by an upstanding flap upon the hinder border of the anterior nostril. The Hake stands apart from the other examples not only on account of its nostrils and rosette which are of a different, somewhat Salmonid, type, but also by the possession of a well developed nasal sac accessory to the true olfactory chamber. The modifications in the Rockling are of minor importance brought about apparently by changes external to the olfactory organ rather than in that organ itself.

## MALACOPTERYGII.

### SALMONIDÆ.

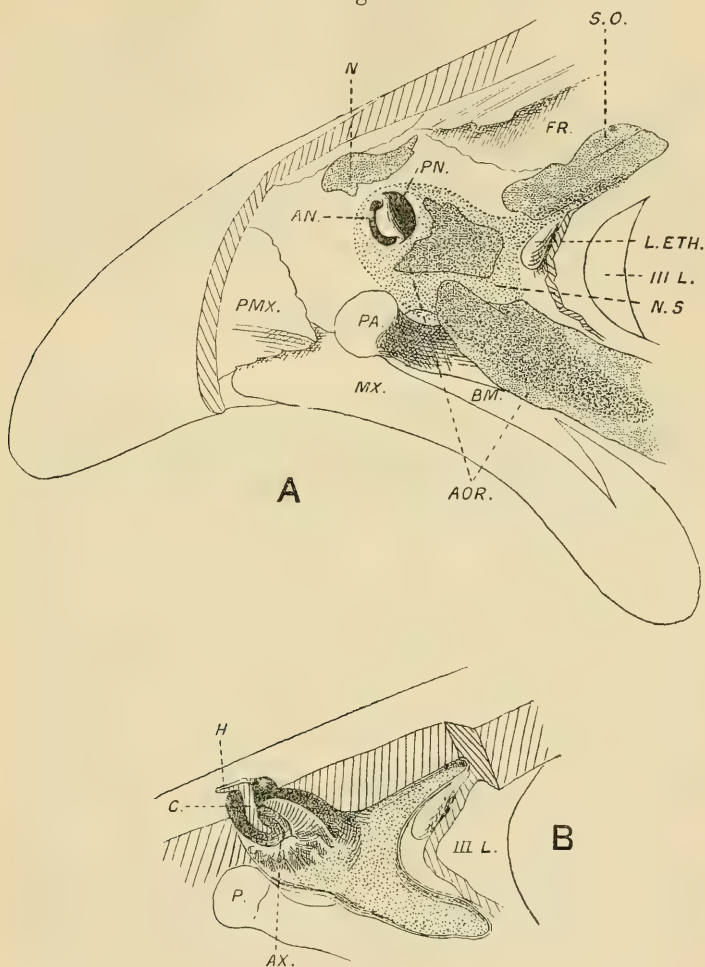
#### *Salmo salar.*

The nostrils lie close together (text-fig. 192, A) upon a level with the top of the eye and about halfway between it and the snout—the posterior in close connection with the central of the three anterior circum-orbital scutes. Both are elongated dorso-ventrally, the anterior being a narrow slit, the posterior more oval. The



bridge of skin between the two is raised to form an upstanding flap and is also prolonged into the nose cavity nearly to its floor

Text-fig. 192.



*Salmo salar.*

**A.** Position and form of nostrils, olfactory cavity, and nasal sac.

**B.** Diagram of nostrils, olfactory chamber, and nasal sac in longitudinal section.

(text-fig. 192, B), forming a pliant curtain to conduct water entering by the anterior nostril through the laminae of the rosette.

The olfactory chamber occupies the usual position in a hollow

in the ethmoid cartilage, but its parts posterior to the rosette are extended beneath the three anterior scutes of the circum-orbital ring, forming a laterally flattened accessory nasal sac prolonged above and below along the anterior contour of the orbit (text-fig. 192, p. 619). This accessory sac is bounded by the orbital ring externally, by the ethmoid and palatine bones and cartilages internally, by the adipose eyelid posteriorly, and by a pad of fat lying on the buccal membrane in front. When the maxilla is retracted towards the eye the cavity of this sac is compressed by the pad of fat.

The rosette is attached to the floor of the olfactory chamber directly beneath the nostrils, and is composed of from 12-14 transversely pleated claw-shaped laminae that radiate from a short central raphe attached anteriorly to the front wall of the anterior nostril.

The posterior laminae of the series are far larger than the others and project freely into the posterior nostril.

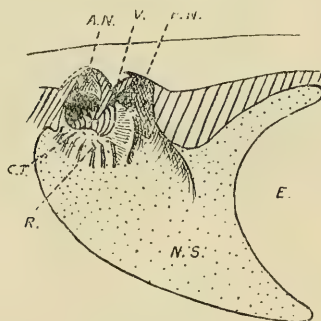
*Osmerus eperlanus.*

The olfactory organ is in all essential points similar to that of the Salmon, but when the mouth was closed forcibly under water no air bubbles escaped from the nostril, as might have been expected from the form and position of the accessory cavities.

*Coregonus oxyrhynchus.*

The olfactory organ is essentially similar to that of the Salmon.

Text-fig. 193.



*Coregonus oxyrhynchus.*

Diagram of nostrils, olfactory chamber, and nasal sac in longitudinal section.

V., valve.

The anterior nostril is, however, surrounded by an upstanding

conical lip and is separated by a deep gutter from the front edge of the posterior nostril, which is raised to form a valve-like flap that probably covers the posterior nostril in inspiration (text-fig. 193).

#### CLUPEIDÆ.

##### *Clupea harengus*.

The nostrils are very similar in form, mutual relations, and position to those of the Salmonidæ examined, particularly to those of *Coregonus*. The olfactory cavity is also closely similar, being produced towards the orbit to form an extensive though laterally flattened sac, which is prolonged both above and below the eye. The lower border of the sac is compressed by the upper edge of the mandible when the mouth is closed.

*Clupea sprattus* does not differ from the Herring.

#### CHIROCENTRIDÆ.

##### *Chirocentrus dorab* \*.

The olfactory organ is essentially the same as in *Clupea* allowing for alterations in the form of the cavity due to the relative shortening of the space between the ethmo-palatine articulation and the orbit. The olfactory laminae are also less strongly defined than in *Clupea* and sink more gradually at the periphery of the rosette area into the general lining of the nasal cavity.

#### MORMYRIDÆ.

##### *Mormyrus* sp.

The nostrils lie about halfway between the eye and the snout set obliquely, the posterior some few millimetres behind and slightly below the anterior. Both are simple perforations, the anterior minute and circular, the posterior larger and oval, with a slightly swollen border.

The olfactory chamber is circular and laterally compressed; its floor (mesial surface) is completely covered by a circular rosette. There are no accessory sacs.

The rosette consists of from 12-16 laminae radiating from a well-marked median raphé connected in front with the anterior lip of the anterior nostril. The individual laminae are low with a swollen and gently convex free border.

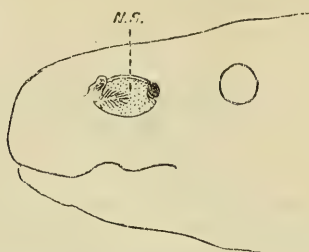
##### *Gymnarchus niloticus*.

The olfactory organ is much the same as in *Mormyrus* though its cavity is more elongated and has a considerable empty space between the rosette and the posterior nostril (text-fig. 194). The anterior nostril also is surrounded by a short tubular lip elevated

\* For this specimen I am indebted to Col. C. E. Shepherd.

behind to form a small valvular flap similar to that of the Gadids and Carps.

Text-fig. 194.



*Gymnarchus niloticus.*

Olfactory organ, from the side.

### Summary.

In the Malacopterygii examined, a distinction can be drawn between the Mormyridæ and the other families. In the former the olfactory organ is of a peculiarly simple type as regards nostrils, cavity and rosette. In the latter (Salmonidæ, Clupeidæ, Chirocentridæ) there is great uniformity and a relatively high degree of complexity. The nostrils are similar in form, position, and detailed relation to the bones of the circum-orbital ring and are modified, though imperfectly, to direct a current of water through the leaves of the rosette. There is, however (except possibly in *Coregonus*), no means of confining the inflow to the anterior nostril. The olfactory chamber is extended by an accessory sac with a similar form and position in all the genera examined and directly affected by the movements of the jaws. The laminae of the rosette though few in number are large and of characteristic claw-like shape.

## OSTARIOPHYSI.

### CYPRINIDÆ.

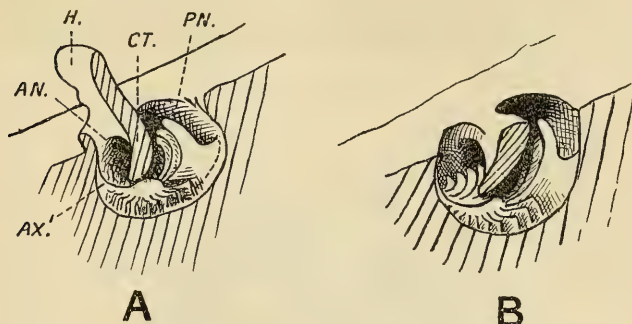
*Tinca vulgaris* (text-fig. 195, A).

The nostrils lie close together near the mid-dorsal line of the face about midway between the eye and the snout. In their general characters they somewhat recall those of the Salmonidæ. Both are circular and wide open. The anterior is bordered by a tubular lip, the hinder parts of which, including the whole area between the nostrils, are prolonged upwards to form a projecting hood and also inwards within the olfactory chamber as a curtain that divides this cavity transversely into two. By this combination of an external hood and an internal curtain water would be



deflected, during the forward progression of the fish, through the anterior nostril down amongst the laminae of the rosette.

Text-fig. 195.



A. Diagram of nostrils and olfactory chamber of *Tinca vulgaris* in longitudinal section.

B. A similar diagram of the olfactory organ of *Abramis brama*.

The olfactory chamber occupies the usual position with regard to the bones of the face, and lodges a rosette of 30 or so laminae radiating in the usual way from a linear raphé. The linguiform process upon the free border of each lamina is peculiarly long and narrow, especially in the hinder parts of the rosette where they form a tuft projecting freely into the posterior nostril.

An essentially similar condition of the olfactory organ was found in *Misgurnus fossilis* and in *Labeo zoneus*.

*Abramis brama* (text-fig. 195, B).

In this genus also the olfactory organ is essentially similar to that of *Tinca* with, however, the rather important absence of a hood-like extension of the posterior lip of the anterior nostril.

#### SILURIDÆ.

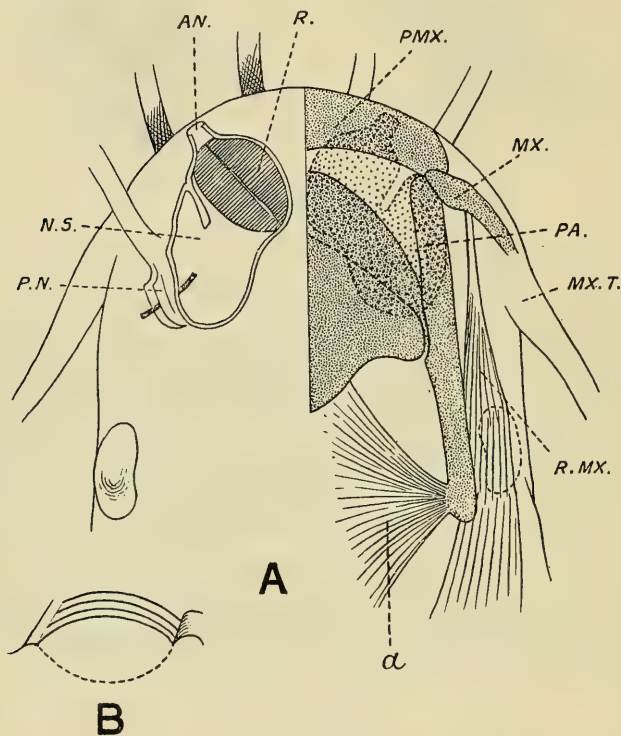
*Clarias lazera* (text-fig. 196, p. 624).

The nostrils lie upon the dorsal surface of the face, the anterior at the end of a short tube overhanging the upper lip, the posterior at some distance (about twice the diameter of the eye) further back. The upper and under margins of the posterior nostril are produced to form thin membranous lips, that would act as valves to prevent inflow of water by this nostril to the olfactory cavity. At its anterior corner is a long nasal tentacle.

The olfactory cavity extends from nostril to nostril but is separable into two distinct segments—(1) an oval chamber in which lies the olfactory rosette, with its long axis directed from the anterior nostril backwards and to the mid-line, and (2) a

smooth vacant cavity leading from the outer and hinder part of the first segment to the posterior nostril. The addition of this empty accessory sac to the olfactory chamber proper, in which lies the rosette and the possession of valvular lips by the posterior nostril, suggests that in some way water is drawn forcibly upon the olfactory rosette through the anterior nostril. At first sight the

Text-fig. 196.

*Clarias lazera.*

- A.** The olfactory organs from above:—On the left the nasal cavity opened; on the right the relation of the olfactory organ to the skeleton.  
**α.** The muscle connecting the hinder end of the palatine bar to the cranium.  
**B.** Diagram of the laminae of the rosette.

mechanism by which this is effected is not apparent, the jaws which in Fishes are the usual agents in such actions being evidently not so in this case. An examination of the rest of the skull in relation to the nasal cavity makes it clear, however, that an intermittent current of water could be, and probably is, produced automatically by the movements that take place between

certain bones when the maxillary tentacles are swung forward. This can best be explained by reference to text-fig. 196 (right side).

The root of the maxillary tentacle is supported and stiffened by the rod of bone that represents the maxilla (MX) which at its proximal end articulates at right-angles with another rod of bone (the palatine bar), that lies in the longitudinal plane and hinges about the middle of its length upon the outer end of the lateral ethmoid. From the free posterior end of the palatine bar a large muscle ( $\alpha$ ) fans out towards the floor of the skull and is there attached. Another muscle (the retractor maxillæ) takes origin from the floor of the skull to the outer side of  $\alpha$ , and running directly forward is inserted by a slender tendon upon the maxilla.

The outer parts of the accessory nasal sac lie above and in close connection with the palatine bar in front of its hinge point.

In action the muscle  $\alpha$  swings out the anterior end of the palatine bar which in turn rotates the maxilla into a longitudinal position shooting the point of the tentacle forwards. The reverse movements to bring the tentacle to rest result from the action of the retractor maxillæ. It will be apparent that owing to its close connection with the palatine bar the outer part of the nasal sac will follow its movements. When this bone swings outwards the sac will be dilated, and when it returns to rest, compressed, causing a stream of water alternately to enter the anterior nostril and to be expelled from the posterior or more probably from both nostrils.

Thus upon structural grounds alone it seems quite clear that when the fish is on the alert it is enabled to bristle its tentacles and sniff by means of one and the same mechanism.

In general appearance the rosette is very similar to that found in the Eels, being of considerable length and composed of a large number of laminae set at right-angles to a median raphé. Each lamina (text-fig. 196) has a simple convex free border without a linguiform process.

*Malapterurus electricus* (text-fig. 197, p. 626).

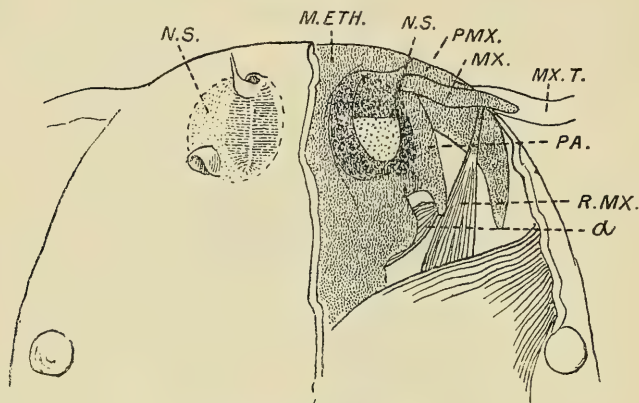
The nostrils are situated in much the same position as in *Clarias*, though relatively closer together. The anterior lies at the end of a short tube the posterior wall of which is prolonged to form a short pointed tentacular process. In a similar way the posterior nostril is guarded in front and at the sides by an upstanding hood-shaped lip.

The olfactory chamber is a simple flattened circular cavity. The rosette is oval and occupies only the inner half of the chamber leaving the outer half vacant.

The cavity is thus separable as in *Clarias*, but to a less degree, into an olfactory chamber lodging the rosette and an accessory sac between the rosette and the posterior nostril. The relations of the vacant part of the cavity to the supporting bones of the

maxillary tentacle are similar to those observed in *Clarias*, and there is little doubt that in a similar way it follows the movements of the palatine bar and acts as an aspirator bulb, though probably in a feeble way, to produce water currents through the leaves of the olfactory rosette.

Text-fig. 197.

*Malapterurus electricus.*

The olfactory organs shown as in text-fig. 196.

MX.T., maxillary tentacle.

#### *Pimelodus sebae.*

The nostrils are very similar to those of *Clarias* though the posterior is smaller, not so distinctly valved, and not connected with a tentacle.

The olfactory chamber is a narrow oval cavity stretching from nostril to nostril and is completely occupied by a long oval rosette fastened to its floor. Its outer wall lies parallel to, but not in any connection with, the palatine bar, and although the movements of the tentacle are effected by a mechanism similar to that in *Clarias* and *Malapterurus*, there can be little or no movement communicated to the walls of the olfactory chamber.

#### *Silurus glanis.*

The nostrils are essentially similar to those of the other Siluroids examined. The anterior lies at the end of a short tube the hinder margin of which is produced as in *Malapterurus* to form a short tentacular process. The posterior lies some considerable distance (at least twice the diameter of the eye) further back and is a longitudinal slit bordered by valvular folds.

The nasal cavity occupies the space between the nostrils and is separable into an anterior half, lodging the rosette, and a vacant posterior half.



So far as could be seen the passage of water through the nose is quite independent of the movements of the bones of the skull and is probably due to the action of cilia, though this leaves unexplained the use or meaning of the vacant prolongation of the nasal cavity and the valvular borders of the posterior nostril.

The rosette is similar in form to that of *Clarias* but the laminae have well pronounced linguiform processes.

#### GYMNOTIDÆ.

##### *Gymnotus electricus.*

The nostrils lie towards the point of the snout upon the upper surface of the face, the anterior at some distance (rather more than the diameter of the eye) in front of and below the posterior. Both are small round apertures, the posterior flush with the surface, the anterior with a swollen border scarcely prominent enough to be called a tube.

The olfactory chamber is a simple flattened cavity of oval or diamond shape in surface view and so placed that its short axis forms the line connecting the nostrils. It is completely filled by a rosette of some 20 claw-shaped laminae arranged around a central axis, and lies directly upon the premaxilla in such a position that its walls could be little if at all affected by the movements of the neighbouring bones of the skull.

#### *Summary.*

In the Ostariophysi examined the olfactory organ of the Carps is entirely different from that of the Siluroids.

In the Carps the organ is of a simple character and very constant in structure so far as observed, differing only in unimportant details. In no instance were there sacs accessory to the olfactory chamber, and when there was any mechanism for the production of water currents in the nose it had the form of a flap of skin standing up behind the anterior nostril to deflect water into it in forward progression.

The Siluridæ on the other hand show a distinct leaning towards the Eels in the structure of the olfactory organ. The anterior nostril tends to be strongly tubular and the posterior is frequently valved. The rosette is more or less elongated and consists of a relatively large number of parallel laminae.

A tendency is also observable in this family towards the development of an accessory sac in extension of the true olfactory chamber which in some instances by movements of certain bones of the face can be contracted and expanded, thus giving rise to water-currents within the nasal cavity.

In the Gymnotidæ the olfactory organ, although peculiar, more nearly resembles that of Siluroids and Eels than that of the Carps.

## APODES.

## ANGUILLIDÆ.

*Anguilla vulgaris.*

The anterior nostril lies at the end of a short tube upon the upper lip not far from the mid-line; the posterior is a simple circular perforation situated close in front of the eye.

The olfactory chamber occupies the area between the nostrils, broadening gradually behind and terminating in a rounded end to the mesial side of the posterior nostril. Its floor and mesial side are covered by an olfactory rosette in which the laminae lie at right-angles to a linear raphé that runs from the anterior nostril to the hinder end of the olfactory chamber. The individual laminae are triangular in outline.

*Conger vulgaris.*

The Conger agrees in all essential particulars with the Eel as regards the structure of its nose.

The olfactory nerves are of enormous size, which accords with Bateson's observation that the Conger is one of the few Fishes that hunt by scent. He also states that the water current in the nose is due to the movement of cilia in the tubular nostril.

## MURÆNIDÆ.

*Muræna tigrina.*

The olfactory organ is very similar to that of an Eel or even more to that of a Siluroid (e.g. *Pimelodus*). Both nostrils are situated at the extremity of a short tube, one projecting forwards above the snout, the other backwards above the eye.

The olfactory chamber is a simple oval cavity lying between the two nostrils and occupied by an elongated oval rosette.

*Muræna zebra* had an olfactory organ of precisely the same character, except that the cavity and rosette were shorter and rounder.

*Summary.*

In this group the examples seen show a very strong similarity in the structure of the nose and a close resemblance also (through the Murænidæ) with that of Siluroids. The anterior nostril (and sometimes the posterior) is strongly tubular and the cavity and rosette are elongated.

## HAPLOMI.

## ESOCIDÆ.

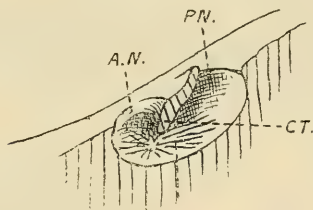
*Esox lucius* (text-fig. 198).

The nostrils lie close together upon the slope of the forehead about one quarter the distance from the eye to the snout facing upwards and forwards. The anterior is circular, of relatively large size (about a quarter the diameter of the eye) and flush with the surface. The posterior is crescentic, with the concavity

directed forward. The anterior border of the narrow bridge of skin between the two is sharply deflected into the nasal cavity.

The olfactory chamber occupies the normal position with regard to the bones of the skull, and is a shallow oval cavity corresponding to the area covered by the nostrils. Its floor is covered by a peculiarly insignificant circular rosette in which the laminæ are low folds of the mucus membrane differing amongst themselves in importance and radiating from a central boss situated directly below the anterior nostril and without any connection with its anterior lip.

Text-fig. 198.



*Esox lucius.*

Diagram of olfactory organ in longitudinal section.

A description of this cavity is given by Blaué.

The organ lies well above the range of any pressure that might be caused by the swelling of the adductor mandibulæ, but probably currents of water are deflected into the cavity of the chamber during forward progression by the tilt of the nostrils towards the front and by the downward bend of the bridge between the two nostrils.

#### SCOPELIDÆ.

##### *Scopelus crocodilus.*

The nostrils are simple circular perforations in a smooth area of skin lying as usual between the lachrymal and nasal scutes. The posterior is four times as large as the anterior and is separated from it by a narrow bridge of integument.

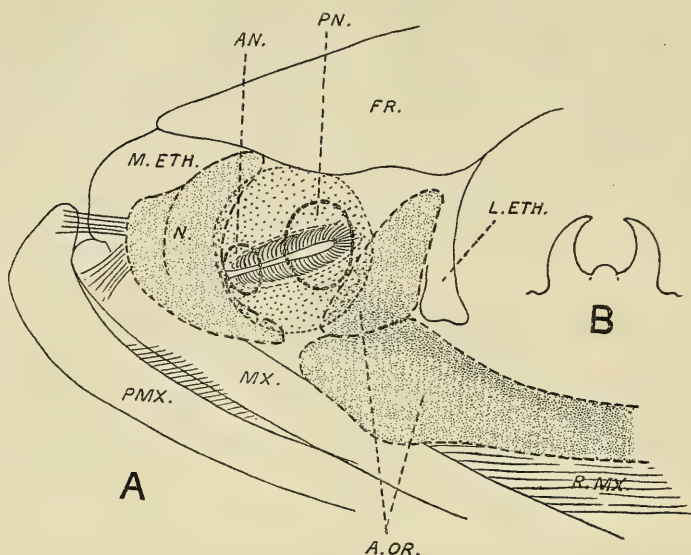
The olfactory chamber is globular and lies partly within the usual hollow in the ethmoid cartilage, but extends also over the maxillary process of the palatine and the head of the maxilla. This somewhat abnormal position is due to the extreme antero-posterior compression of the front part of the face.

The lining membrane of the chamber is deeply pigmented except upon the rosette, which is brilliantly white in contrast.

The rosette is of very unusual form (text-fig. 199, A), being linear with its axis lying in the plane of the two nostrils. It is, however, composed as usual of a series of laminæ arranged along the sides and around the posterior end of an elongated central

raphé. The individual laminae (text-fig. 199, B) are very small, especially in the length of their attached base, and are acutely pointed.

Text-fig. 199.

*Scopelus crocodilus.*

- A. Position and form of nostrils and olfactory chamber.  
 B. Diagram of the laminae of the rosette.

## CYPRINODONTIDÆ.

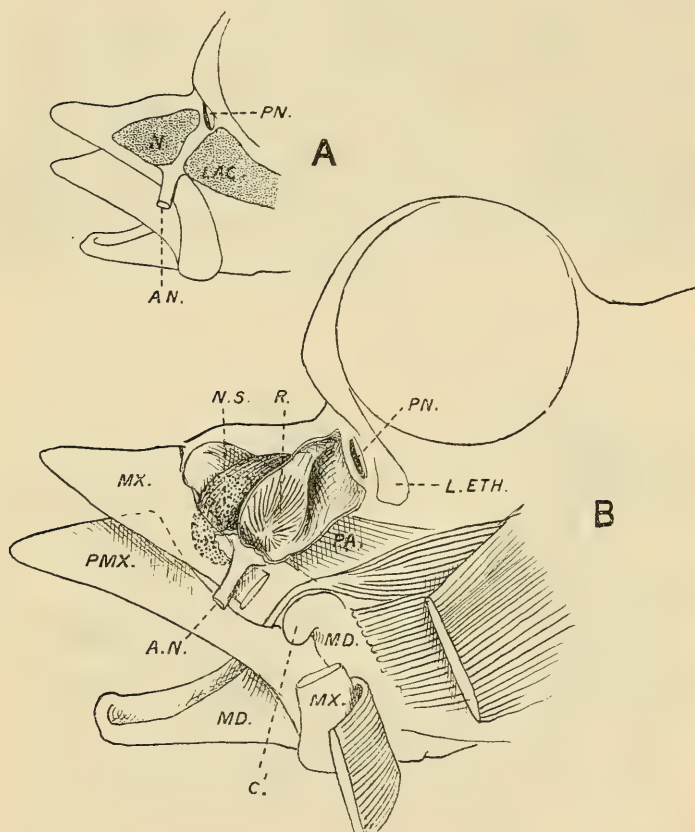
*Anableps microlepis.*

The posterior nostril lies just in front of the lower part of the eye. It is a vertical slit, and is apparently valved against ingress by the thinness and flexibility of its posterior lip. The anterior nostril lies at the end of a short tube overhanging the edge of the maxilla about its centre (text-fig. 200, A). Forceful closure of the mouth under water caused air within the nose-cavity to bubble from the posterior nostril, indicating the presence of accessory sacs in connection with the olfactory chamber. Dissection shows that the nasal cavity is in fact separable into two parts—one just within the anterior nostril occupied by a simple oval rosette, and thus the olfactory chamber proper, and another between this and the posterior nostril lined by smooth membrane and extending forward deep to the rosette across the maxillary process of the palatine and beneath the maxilla to the hinder edge of the premaxilla. This second portion of the cavity is an accessory nasal sac whose state of compression depends upon the movements of the premaxilla, and acts as an aspirating mechanism for the production of water currents in the nose-cavity. The action of the jaws when



the mouth is opened and closed is peculiar. When the lower jaw is depressed by the action of the gular muscles the premaxilla is strongly protruded by the forward pressure of a hooked process of the coronoid border of the mandible (text-fig. 200, B, c') upon the hinder margin of the premaxilla. By this movement of the premaxilla the membranes between it and the palatine are stretched

Text-fig. 200.

*Anableps microlepis.*

A. Position of the nostrils.

B. The nasal cavity in its relation to the neighbouring bones of the face.

C', hooked process on the coronoid border of the mandible that protrudes the premaxilla.

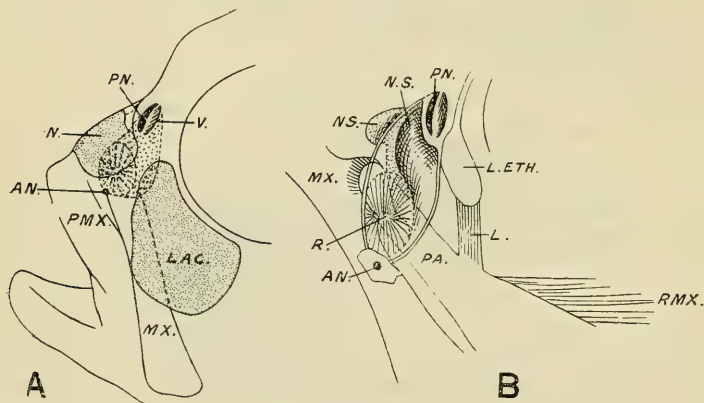
and the nasal sac distended. Closure of the jaws by the contraction of retractor muscles inserted upon the premaxilla and the coronoid process of the mandible is accompanied by a retraction of the premaxilla and the compression of the nasal sac. In this mechanism

the maxilla is comparatively fixed, its lower end forming the fulcrum upon which the premaxilla swings backwards and forwards.

*Orestias lesueurii*.

In this species the olfactory organ is of the same type as in *Anableps*, though differing from it in detail. The anterior nostril is not tubular but is a simple hole, minute and easily overlooked, lying near the anterior margin of the maxilla towards its upper extremity. The posterior nostril on the other hand (text-fig. 201, A) is a large oblique slit in front of and above the eye and is bordered posteriorly by a valvular flap, which is separated from the parts behind it by so deep a gutter that at first sight it might be taken to be the posterior nostril, and the true nostril mistaken for the anterior, simulating such a pair of closely applied nostrils as those of the Herrings. The nasal cavity is essentially similar to that of *Anableps*, but the accessory sac is not so large and passes inwards around the posterior border of the maxillary process of the palatine and not forwards towards the premaxilla.

Text-fig. 201.



*Orestias lesueurii*.

**A.** The nostrils in their relation to the superficial bones of the face.

**B.** The form and position of the olfactory cavity.

L., ligament between the ethmoid and palatine.

Movements of the jaws had but little effect apparently upon the contents of the nose-cavity, but when the operculum was raised and lowered air-bubbles could readily be expelled from the posterior nostril. This effect seems to be due to the movements of the maxillary process of the palatine. This bone is attached in front in the usual way (though loosely) to the maxilla and at the root of its maxillary process by a long ligament to the lateral ethmoid. As the gill-cover is opened the maxillary process of the palatine rotates inwards and backwards around this ligament as a

pivot, compressing the accessory nasal sac that rests upon its posterior and inner surfaces. The jaw movements may possibly also be of some little assistance in the compression of this sac, but those of the gill-cover appear to be by far the more important.

The rosette is very feeble and consists of a series of low pleats radiating from a central boss.

#### *Summary.*

In *Esox* and *Scopelus* the olfactory organ is quite simple with open non-specialized nostrils and plain cavity. It differs in the two genera chiefly in the form of the rosette, which in *Esox* is circular and very poorly developed, in *Scopelus* linear and sharply defined with strong though small laminae.

In the two Cyprinodonts the organ is of a quite different and more highly specialized type. The anterior nostril may be tubular, the posterior is valved. The nasal cavity is complicated by the presence of an accessory sac of characteristic form and position, which from its position is capable of being compressed by the bones of the face. The rosette is feeble and in *Orestias* resembles in some particulars that of the Pike.

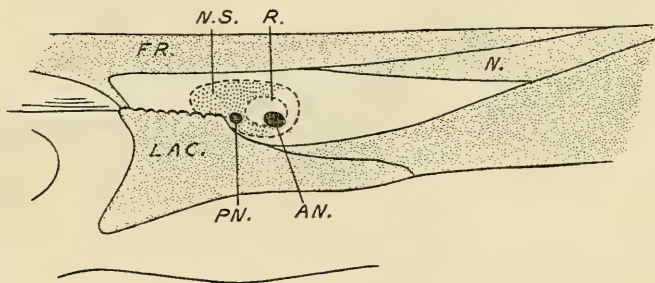
### CATOSTEOMI.

#### FISTULARIIDÆ.

##### *Fistularia*.

The nostrils are two plain oval perforations in an area of soft skin situated close in front of the eye between the frontal and lachrymal bones. The posterior is narrow, with its chief axis

Text-fig. 202.



*Fistularia* sp.

Right olfactory organ showing relative proportions of olfactory (R.) and indifferent (N.S.) areas of the nasal cavity.

longitudinal, the anterior about three times as large. The bridge of skin between the two is about equal in breadth to the long axis of the anterior nostril. The olfactory chamber is oval but very shallow. It lies upon the bones of the skull (lateral ethmoid) and extends backwards some distance beyond the posterior nostril,

its front half only being occupied by the rosette. The laminae of the rosette are very feeble and resemble those of the Pike.

#### GASTROSTEIDÆ.

The olfactory organ of *Gastrosteus* has been described by Solger. He states that it has in connection with the lower part of the olfactory chamber an accessory nasal sac. One nostril only is present. It has the form of a short tube, situated in the normal position between the nasal and lachrymal scutes.

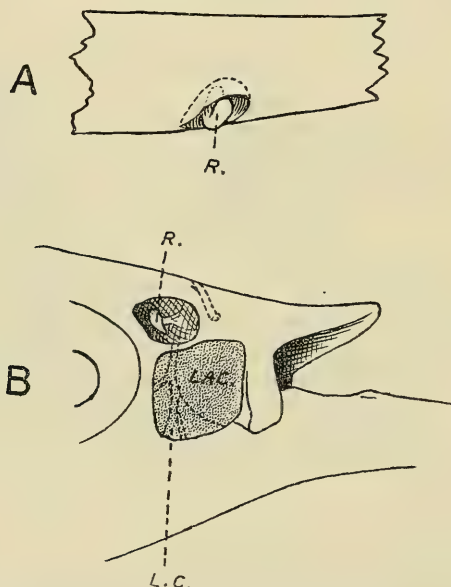
#### PERCESOCES.

##### SCOMBRESOCIDÆ (see Blaue).

*Belone vulgaris* (text-fig. 203, A).

The olfactory organ of this species has been described by Blaue. The chief peculiarity in it is that the olfactory chamber is a simple open pit, from the centre of which protrudes a solid mushroom-shaped boss, representing the usual laminate rosette.

Text-fig. 203.



A. The right olfactory organ of *Belone vulgaris*, from above.

B. The right olfactory organ of *Hemirhamphus*, from the side.

L.C., lateral-line canals in the lachrymal.

*Hemirhamphus* (text-fig. 203, B).

The olfactory organ is very similar to that of *Belone*, but the central boss is relatively smaller.



*Exocoetus volitans.*

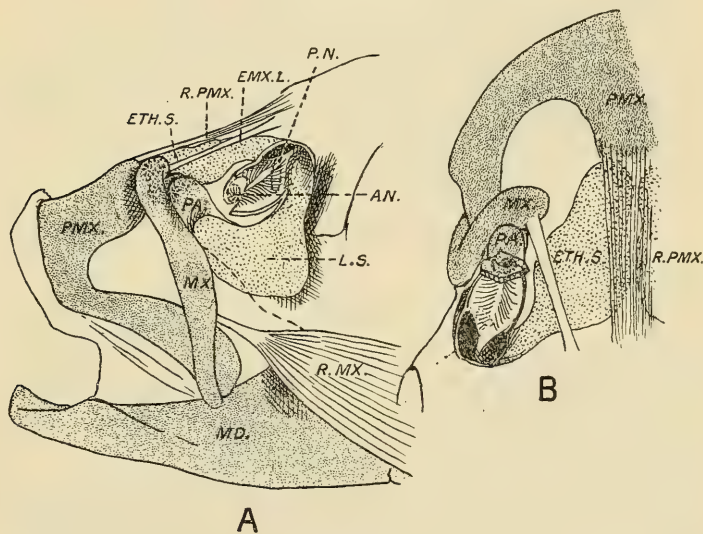
The olfactory organ is similar to that of *Hemirhamphus*. It is worthy of notice that in *Hemirhamphus* and *Exocoetus* the tubules of the lateral line that traverse the lachrymal bone open directly into the lower part of the olfactory chamber. This probably indicates that the single opening of the olfactory pit is not primitive, but a secondary modification, the original openings having spread to include within the pit what at one time was the external surface of the face.

## MUGILIDÆ.

*Mugil chelo.*

The nostrils lie about halfway between the eye and the snout, bounded as usual by the lachrymal and nasal bones. The anterior nostril is circular, with a short tubular lip higher behind than in front. It is separated by a bridge of skin about twice its

Text-fig. 204.

*Mugil chelo.*

A. The olfactory organ, in position, from the side.

B. The same, from above.

diameter in breadth from the posterior nostril, which is a vertical slit protected from ingress by a thin, transparent valvular extension of its anterior border.

The olfactory chamber is oval and of the same length as the space between the nostrils. It lies in the usual hollow in the ethmoid behind the maxillary process of the palatine. Its hinder parts, which are unoccupied by the rosette, extend for some little

distance beyond the posterior nostril, and here are dilated above and below the ridge that carries the olfactory nerve to the rosette to form two large accessory sacs. The upper sac (ethmoidal) bends forward beneath the ethmo-maxillary ligament parallel to the upper margin of the olfactory chamber, and fills in all the space available between the mesethmoid and the backward process of the premaxilla. The lower (lachrymal) sac, after passing down upon the lateral ethmoid, expands in the space between the lachrymal bone, the palatine arcade and buccal membrane, and the maxilla.

It will be apparent from the close relations of these sacs to the bones of the mouth that their expansion or contraction will depend upon the movements of these bones. This is particularly the case with regard to the ethmoidal sac, which is greatly expanded as the premaxilla shoots forward in the protrusion of the jaws and compressed as it is retracted. The effect of the movements of the maxilla upon the lachrymal sac is less apparent, although the sac is visibly compressed by the hinder margin of this bone as it swings back during the closure of the mouth.

By forcibly closing the mouth under water it is possible to cause the ejection of a stream of air-bubbles from both nostrils.

The rosette is oval, slightly pigmented, and not very strongly defined. Its laminae have the normal radial arrangement around a linear raphé attached in front to the anterior wall of the anterior nostril. The individual laminae (of which there are about 30) are bluntly claw-shaped.

#### OPHIOCEPHALIDÆ.

##### *Ophiocephalus marulius.*

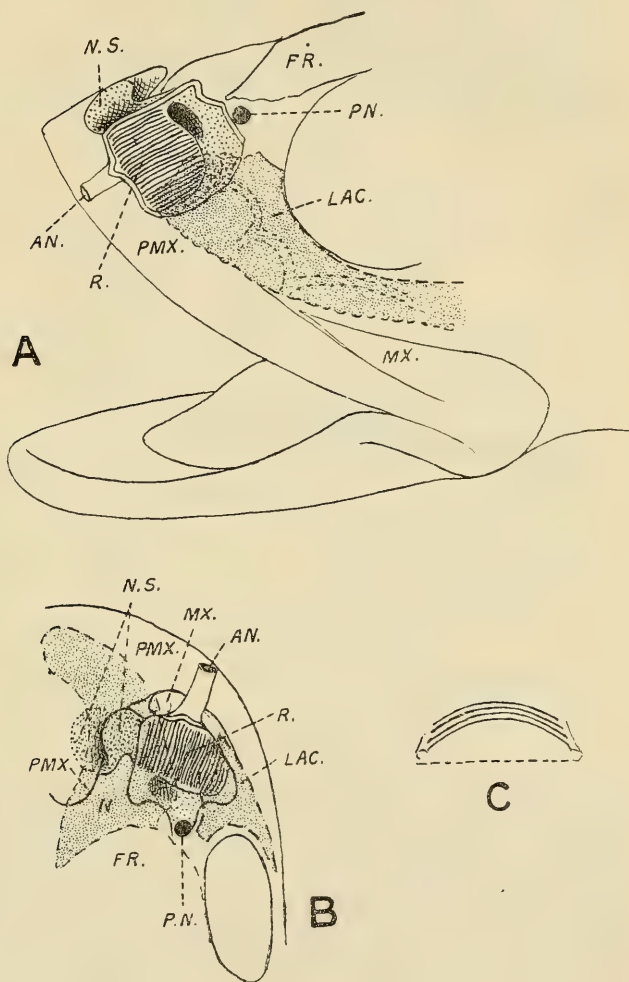
The nostrils lie between the upper anterior border of the eye and the snout in an area of soft skin between the nasal and lachrymal scutes, separated from each other by a space equal to the diameter of the eye. The anterior nostril is a simple perforation at the end of a tube overhanging the premaxilla, the posterior a circular hole flush with the surface of the head close in front of the frontal scute.

The nasal cavity consists of two divisions, an olfactory chamber proper occupying the anterior half of the space between the two nostrils, and an accessory sac comprising the parts of the cavity between the rosette and the posterior nostril, and extending forward deep to the true olfactory chamber to the backward process of the premaxilla.

The rosette is quadrangular in shape and consists of a series of laminae set parallel to one another in the longitudinal plane. Each lamina (text-fig. 205, C) has a gently curved free margin without linguiform process. The accessory sac is so closely applied to a considerable part of the backward process of the premaxilla that it necessarily shares in the movements of this bone, being compressed when it is retracted, expanded when it protrudes. It

thus no doubt acts as an aspirator bulb to produce water currents through the leaves of the olfactory rosette.

Text-fig. 205.



*Ophiocephalus marulius*.

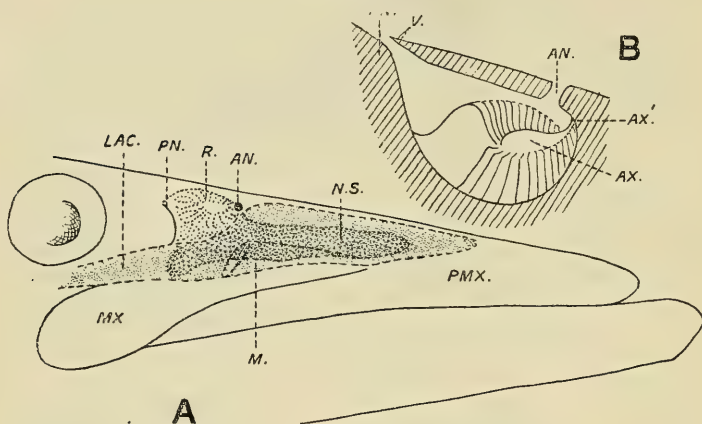
- A. The left olfactory organ, from the side.
- B. The same, from above.
- C. Diagram of the olfactory laminae.

## SPHYRÆNIDÆ.

*Sphyræna cameroonii*.

The nostrils lie in an area of soft skin above the lachrymal bone at a quarter the distance from the eye to the snout. The anterior is a small round hole, the posterior a vertical slit concave posteriorly and valved against ingress by the thinness of its backwardly directed anterior lip. The bridge of skin between the nostrils is rather broader than the posterior nostril is long, the latter being eight times the diameter of the anterior nostril.

Text-fig. 206.

*Sphyræna cameroonii*.

**A.** Position of the olfactory organ and nasal sac relative to the bones of the face.

**B.** Diagram of the olfactory chamber in longitudinal section.

M., the muscle fragment mentioned in the text.

The olfactory chamber lies beneath the nostrils and is occupied by a well-defined rosette. Its ventral parts are extended downwards and forwards under cover of the lachrymal bone to form a long flattened accessory nasal sac, which extends from the ethmo-lachrymal articulation to the anterior end of the lachrymal bone.

The rosette is of the normal oval type. It consists of about 30 strongly convex laminae (text-fig. 206, B).

It is difficult to suggest the use of the accessory sac, as the specimen observed was in a fragmentary condition; but the presence of a piece of muscle and tendon (probably the retractor maxillæ) upon the lower border of the lachrymal and underlying the accessory sac, suggests that it may very likely be used as an aspirator bulb, compressed either by the swelling of this muscle or by the upward swing of the maxilla when the mouth is closed.



*Summary.*

In the Percosoces the olfactory organs show a wide range of variation in the above examples of the different families observed. In the Scombresocidæ they are of a quite peculiar and characteristic form, unlike that seen in any other group of Teleostei. In the Mugilidæ a very distinct type occurs in which the olfactory chamber is enlarged by two accessory empty sacs, closely resembling in form and position the accessory sacs found in the majority of Acanthopterygii. In *Ophiocephalus* the general structure of the nose and the position of the single accessory sac in connection with it bear a considerable resemblance to that of the Cyprinodontidæ, differing however in the form of the rosette, which is of a type found elsewhere only in certain Pleuronectids. In *Sphyræna* there is yet another type of nose, with a large and very simple accessory sac stretching forward like that of *Merluccius* or *Zeus*.

## ACANTHOPTERYGII.

## PERCIFORMES.

## PERCIDÆ.

*Perca fluviatilis.*

The nostrils, which lie high up on the face slightly nearer the eye than the snout, are both circular apertures of some little size—the posterior flush with the general surface, the anterior surrounded by a low tubular lip. They are separated by a bridge of skin about twice the diameter of the posterior nostril in breadth. The olfactory chamber occupies the usual hollow in the ethmoid and corresponds in length to the area between the nostrils. It is occupied by a prominent oval rosette of some fifteen large laminae, with strongly convex and swollen free margins.

Above and below the rosette the nasal cavity is dilated to form a pair of accessory empty sacs, the upper of which runs inwards and forwards beneath the ethmo-maxillary ligament into the spaces between the mesethmoid and the backward process of the pre-maxilla and deep to the maxillary process of the palatine. The lower dilatation extends in a similar way between the lachrymal scute and the palate to the maxilla. Both these accessory sacs, although in comparison with those of many other genera of Acanthopterygii poorly developed and but indefinitely marked off from the true olfactory chamber, evidently belong to the same type and are in a similar way affected by movements of the pre-maxilla and maxilla as the mouth is opened and closed, giving rise to water currents in the olfactory chamber.

## LATRIDÆ.

*Latris ciliaris* \*.

The olfactory organ closely resembles that of the Perch, although

\* This specimen was obtained through the kindness of Col. Nicholson.

smaller and with less strongly developed accessory sacs, the upper (ethmoidal) one being represented by a mere recess above the hinder part of the rosette, and the lower (lachrymal) extending forward only as far as the root of the maxillary process of the palatine.

Neither of the sacs seems to be within reach of the direct effects of the movements of the jaws.

The rosette is not so strong and definite as in the Perch. It is of the usual oval type and consists of about 30 laminae, each with a well-formed, almost claw-shaped linguiform process.

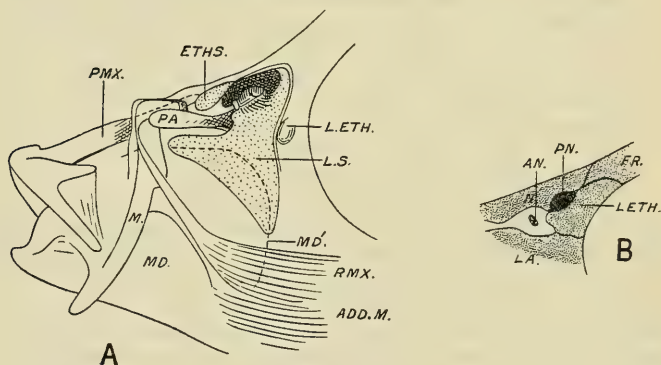
#### CAPROIDÆ.

##### *Capros aper.*

The nostrils lie in a similar position to those of the Perch, the anterior within an area of smooth skin, the posterior closely surrounded by scutes (text-fig. 207, B).

The anterior nostril is a small and simple oval aperture, with its long axis vertical; the posterior, which is four or five times as large as the anterior, is pear-shaped, with its swollen end directed forwards. The bridge between the two is less than the length of the posterior nostril in breadth.

Text-fig. 207.



*Capros aper.*

**A.** Left olfactory organ, from the side.

**MD.** position of the coronary border of the mandible when the mouth is shut.

**B.** Surface-view of the nostrils.

The nasal cavity is disposed much as in the Perch, but the rosette is relatively smaller and the lachrymal accessory sac larger and far more dilated ventrally towards both the head of the maxilla and the hinder end of the lachrymal scute.

The ethmoidal accessory sac is comparatively small, being a small forward extension of a general dilatation of the olfactory chamber above the rosette. It probably is not of much service as

an aspirator, although it can undoubtedly be compressed by the retraction of the premaxilla.

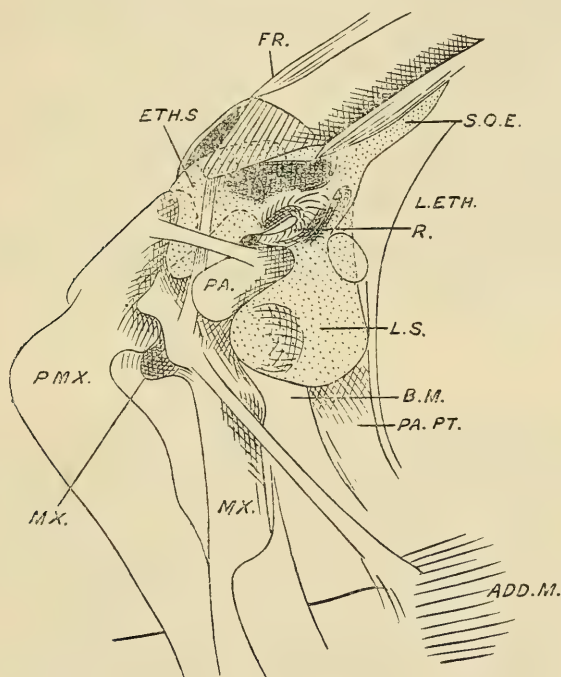
The lachrymal sac, on the other hand, is evidently most effective in producing water currents in the nose, for its lower border is extensively indented by the coronoid border of the mandible when the mouth is closed.

#### BERYCIDÆ.

##### *Beryx delphinus*.

The nostrils lie about halfway between the eye and the snout towards the dorsal line of the head, surrounded by the nasal, lachrymal and frontal bones. Both are large, oval, and widely

Text-fig. 208.



##### *Beryx delphinus*.

Left olfactory organ, from the side.

PA.PT., palato-ptyergoid arcade.

S.O.E., supraorbital extension of the nasal cavity.

open, the anterior about half the size of the posterior. The bridge of skin between the two is relatively narrow and is produced as a transverse curtain into the cavity of the olfactory chamber.

The rosette which covers the floor of the olfactory chamber is sharply defined and very prominent, like that of the Perch. It is composed of about thirty claw-shaped transversely pleated laminae arranged in the usual way radially around the hinder parts of a linear raphé.

The whole of the olfactory chamber above the rosette is dilated to form a peculiarly capacious ethmoid accessory sac, that extends backwards into two hollows beneath the anterior end of the frontal, inwards between the backward process of the premaxilla and the mesethmoid, and forwards between the palato-premaxillary and ethmo-maxillary ligaments and the greatly elongated head of the maxilla.

In a similar way the wall of the olfactory chamber below the hinder end of the rosette is expanded beneath the lachrymal bone, forming a pear-shaped lachrymal nasal sac that rests partly on the palatine and partly upon the buccal membrane between its anterior border and the maxilla.

The hinder part of the olfactory chamber is also produced backwards beyond the posterior nostril to form a narrow conical sac above the eye within the hollow between the lower edge of the frontal and the lateral ethmoid. The resemblance should be noticed between this posterior extension and that seen in the Salmon and Herrings.

The ethmoid and lachrymal sacs are strongly compressed by the movements of the premaxilla and maxilla when the mouth is closed.

#### MULLIDÆ.

##### *Mullus barbatus.*

The nostrils are inconspicuous, but occupy a similar position upon the face to those of the previously described Perciformes, although separated by a considerably broader bridge of skin. The distance between them is due in large part to a tubular extension of the nose-cavity between the olfactory chamber and the posterior nostril. The anterior nostril is a small round hole, the posterior a narrow vertical slit, opening backwards and valved against ingress by the thinness and flexibility of its backwardly directed anterior lip.

The olfactory chamber is expanded above and below the olfactory rosette to form a pair of accessory sacs similar to those of the Perch, but longer and more slender and separated more definitely from the olfactory chamber itself. Although occupying the normal positions between the premaxilla and ethmoid and near the hinder border of the maxilla, these sacs, owing probably to their small capacity, do not seem to be greatly compressed by the movements of these bones—at least, no air-bubbles could be driven from the nostrils by forcibly closing the mouth under water.

The rosette, as in the other Perciformes, is oval and very prominent. The laminae are few in number and, like those of the Perch, have a sharply convex free border.



## SPARIDÆ.

*Pagellus centronotus.*

The olfactory organ is comparable to that of the Perciformes previously described, particularly to that of *Mullus*, but is in every way better developed.

The nostrils have a similar position and form, differing only in the fact that they are relatively closer together and that the posterior is protected from ingress by a special valvular fold (text-fig. 209, C, p. 644) attached to the inner surface of its posterior lip.

The olfactory chamber is almost completely filled by a very prominent oval rosette of the normal type, in which the individual laminae have a sharply convex free margin. The cavity is not prolonged between the hinder margin of the rosette and the posterior nostril, but above and below the ridge that carries the olfactory nerve to the rosette are a pair of clearly defined oval apertures that lead into ethmoid and lachrymal sacs of a similar character to those of *Mullus* or other Perciformes, but larger and more markedly differentiated from the true olfactory chamber by the narrowness of their channels of communication. The position of the olfactory chamber and accessory sacs with regard to the bones of the skull is similar to that previously described, the lachrymal sac lying beneath the lachrymal bone upon the palatine and the buccal membrane and reaching forward to the strongly convex posterior border of the maxilla, and the ethmoid sac occupying the usual position between the ethmoid and the backward process of the premaxilla. From their position both sacs, and especially the lachrymal, must be strongly compressed during the closure of the mouth.

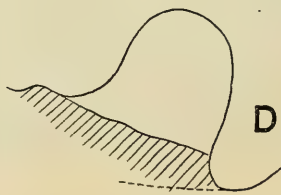
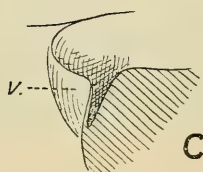
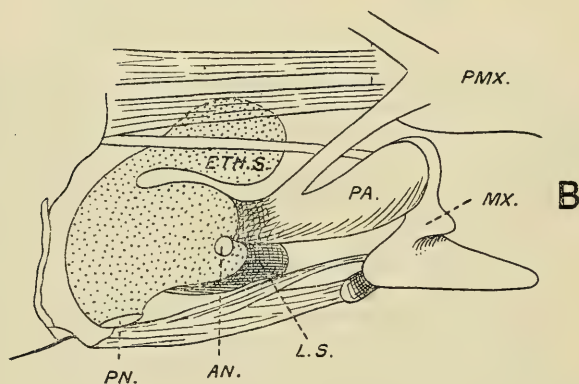
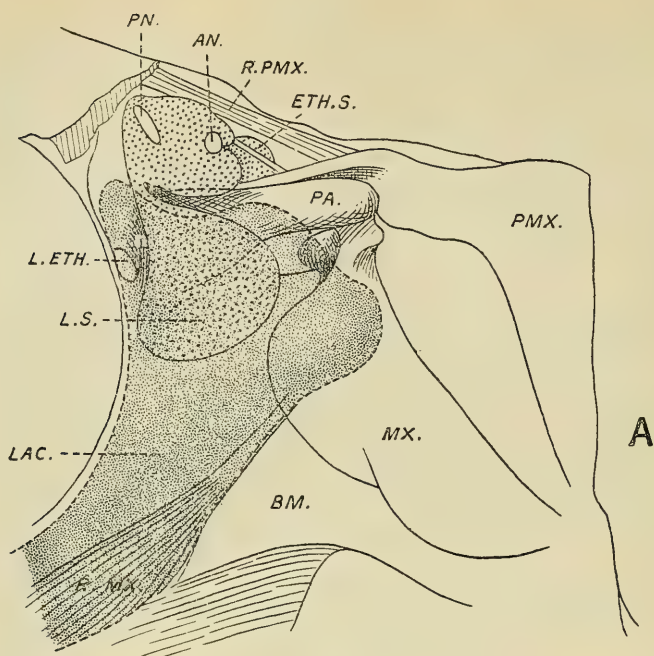
*Summary.*

The olfactory organ shows a strong general resemblance in all the members of the Perciformes examined, accompanied by an interesting series of variations tending towards more perfect specialization.

The nostrils occupy in all a very similar position, rather high up on the face not far in front of the upper border of the eye. In the simpler forms (*Perca*, *Latris*, *Capros*, and *Beryx*) they are both widely open, in *Mullus* and *Pagellus* the posterior is valved. In all the olfactory chamber is dilated beyond the actual olfactory area, the dilatation showing a gradual differentiation into two clearly defined accessory sacs, one related to the ethmoidal region in such a way as to be compressed and expanded by the movements of the premaxilla, the other lying upon the palatine bone and the buccal membrane, and responding in a similar way to the movements of the maxilla or (*Capros*) mandible.

Within the group a line can be drawn between *Perca*, *Latris*, *Capros*, and *Beryx* on the one hand, where the accessory sacs, although differing in size, are still but little cut off from the olfactory chamber, and in which the posterior nostril is not valved,

Text-fig. 209.



and *Mullus* and *Pagellus* on the other, in which the posterior nostril is valved and the sacs open into a definite part of the olfactory chamber by restricted orifices.

A parallel specialization is also observable in the differentiation of the jaw-muscles in these two groups.

## SCOMBRIFORMES.

### SCOMBRIDÆ.

#### *Scomber scombrus.*

The nostrils lie in the posterior half of the distance from the eye to the snout separated by a bridge of skin 8 mm. or so in breadth. The anterior nostril is a small and quite simple circular hole, the posterior a vertical slit about 4 mm. long, and valved against ingress by the thinness and flexibility of its backwardly directed anterior lip.

The olfactory rosette is prominent and sharply defined, and lies as usual directly beneath the anterior nostril. It consists of about 30 claw-shaped laminae arranged as usual radially around the hinder parts of a linear raphé.

The olfactory chamber is dilated posteriorly and below to form an extensive though very shallow accessory sac, which is divided into upper and lower parts by the ethmo-lachrymal articulation, the upper part passing beyond the posterior nostril to the anterior and upper edge of the orbit, the lower extending downwards and forwards upon the palatine bone and buccal membrane to the upper border of the maxilla, by which it is compressed when the mouth is closed.

## ZEORHOMBI.

### ZEIDÆ.

#### *Zeus faber.*

The nostrils lie close in front of the eye, near the dorsal mid-line of the face. Both are wide open and of large size, the anterior being a circular aperture about 3 mm. in diameter, with a thick but low tubular lip higher behind than in front, and the posterior a large bean-shaped opening (7 mm.  $\times$  4 mm.) lying close behind the anterior, and partly embracing it with its concave border.

The rosette, which is plainly visible through the posterior nostril, is prominent and sharply defined. It consists of a

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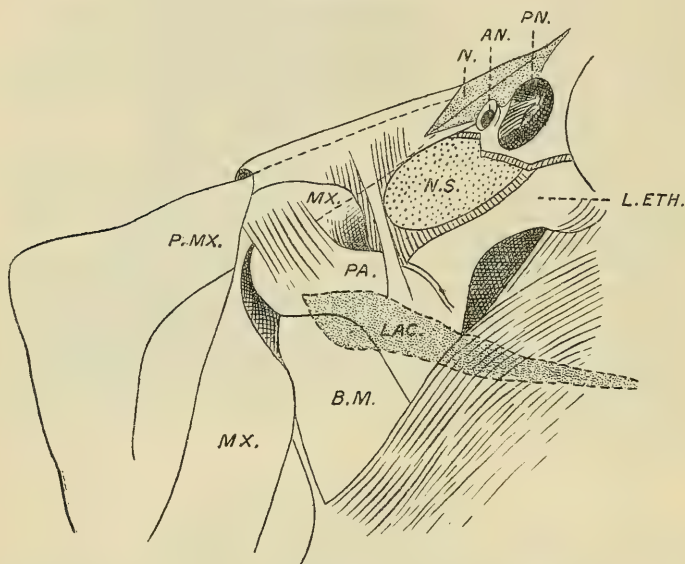
Explanation of Text fig. 209 (see opposite).

#### *Pagellus centrodontus.*

- A. Olfactory organ in position, from the side.
  - B. The same, from above.
  - C. The valve (V) upon the hinder lip of the posterior nostril, in section.
  - D. Diagram of a lamina of the rosette.
- BM., buccal membrane. R.PMX., retractor premaxilla.

swollen cushion-like base, from the surface of which protrude the apices of about thirty sharp-pointed laminae attached to a linear central raphé in the usual way. Owing to the abnormal structure of the face the olfactory chamber does not occupy the usual hollow in the ethmoid, but lies higher up in a cavity between the backward process of the premaxilla and the upper part of the ethmoid, separated by a prominent ridge from the cavity of the ethmoid, within which it would normally be lodged.

Text-fig. 210.

*Zeus faber.*

Left olfactory organ, from the side, showing abnormal position.

The anterior parts of the cavity below the rosette are produced forward above the same ridge of bone towards the expanded head of the maxilla, forming a large finger-shaped accessory sac, filled with mucus and separated by a large lymph-space from the deeper parts of the skull.

This accessory sac, except for its position with regard to the facial bones, is in many ways very similar to that of *Merluccius*, and it should be noted that both were filled with mucus.

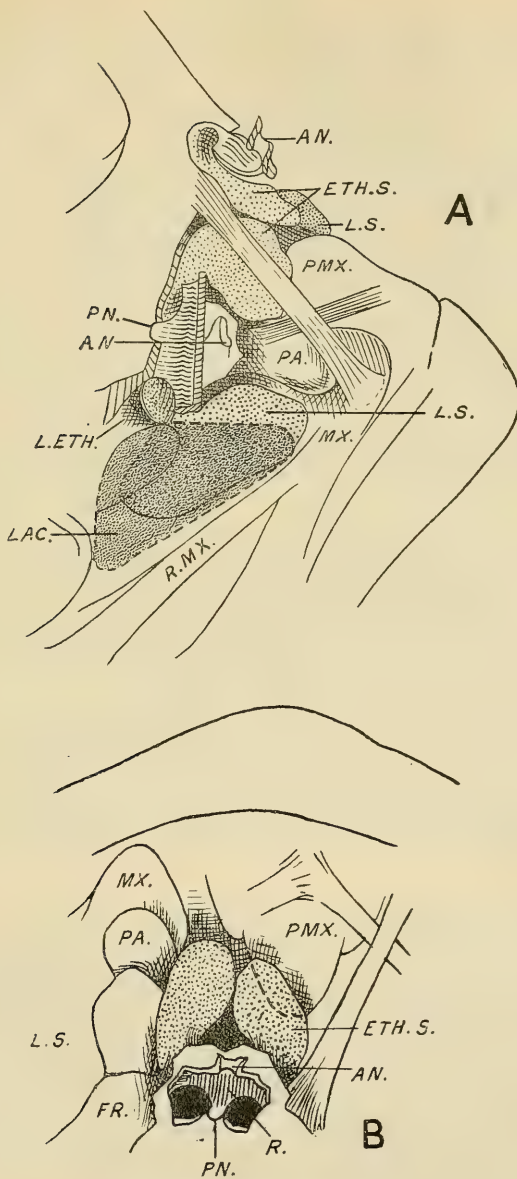
#### PLEURONECTIDÆ.

##### *Hippoglossus vulgaris.*

The olfactory organs are situated on either side of the head, that of the right in front of the interorbital ridge, that of the left just to the left of the dorsal line of the body.



Text-fig. 211.

*Hippoglossus vulgaris*.

A. Position of both olfactory organs, from the ocular side.

B. Left olfactory organ, from above,

The anterior nostril is tubular with the hinder lip raised to form a narrow leaf-like appendage; the posterior is a small circular open hole. They are separated by a bridge of moderate breadth (about three times the diameter of the posterior nostril).

The rest of the nose differs somewhat on the two sides of the head. On the right (ocular) side the olfactory chamber is broader than long, and contains a correspondingly broad rosette, in which the laminae, which are about twenty-five in number, lie longitudinally and parallel to one another. The individual laminae have a sharply angled free border. The hinder margin of the rosette is attached by its middle to the posterior wall of the olfactory chamber by the membranous fold that carries the olfactory nerve, but on either side of this attachment it forms the free anterior border of an oval hole that leads into an accessory sac. The nasal sacs in form, position, and mode of connection with the olfactory chamber resemble the ethmoidal and lachrymal sacs of other Acanthopterygians (e. g. *Pagellus*). The ethmoidal passes upwards beneath the ethmo-maxillary ligament into the space between the mesethmoid, the backward process of the premaxilla, and the maxillary process of the palatine; the lachrymal extends downwards and forwards in a similar manner deep to the lachrymal and the overhanging lachrymal process of the lateral ethmoid to the hinder border of the maxilla, lying upon the palatine bone and the buccal membrane. The sacs are compressed by the movements of the premaxilla and maxilla in the closure of the mouth. Upon the blind side the nose is essentially similar, but owing to the rotation of the face the form and position of the accessory sacs have become somewhat distorted.

Both sacs lie above the maxillary process of the palatine, being rotated forward on either side of the olfactory chamber, and lying side by side in the hollow of the ethmoid that also lodges the olfactory chamber. The ethmoidal sac is the larger of the two and reaches the backward process of the premaxilla; the lachrymal sac terminates in front above the root of the maxillary process of the palatine.

#### *Pleuronectes platessa*.

The olfactory organs of the Plaice are quite similar to those of *Hippoglossus*\*, except that the posterior nostrils are surrounded by a thin upstanding valvular lip. Their topography has been described in detail by Cole, if anything with too great elaboration, for the accessory sacs are not strictly speaking subdivided into the definite sacculations described by Cole, but are simple pear-shaped bags fitting into the interstices between the different bones with which they come in contact, and capable, when the bones are stretched apart, of being completely smoothed out, leaving no trace of permanent subdivision.

\* A rosette with longitudinally arranged laminae has been recorded (Bateson) for three species of *Pleuronectes* besides *P. platessa*.

*Rhombus maximus.*

The olfactory organs lie on the ocular and blind sides of the head in positions quite similar to those of *Hippoglossus*. The nostrils on the ocular side resemble those of *Hippoglossus*, except that the anterior nostril is less strongly tubed and the posterior nostril relatively larger. Upon the blind side the anterior nostril is surrounded by a very characteristic flat circular leaf-like expansion (text-fig. 212, A, p. 650). A similar flap is mentioned for the Brill (*R. levis*) by Bateson (*l. c.* p. 231), and, as described later, occurs also in the Whiff (*Arnoglossus*).

The olfactory chamber, on both sides, is oval and lodges an oval rosette in which the laminae radiate in the usual way from a linear raphé.

Upon the ocular side the hinder end of the olfactory chamber gives origin to a pair of accessory sacs comparable in every way to those of the ocular side of *Hippoglossus*.

Upon the blind side there is only one accessory sac which has the position and general relations of an ethmoidal sac, and communicates with the olfactory chamber by a wide opening above the hinder part of the rosette.

*Arnoglossus megastoma.*

The nostrils are similar to those of the Turbot (Bateson, *l. c.* p. 231). Upon the ocular side the olfactory chamber is oval and exceedingly shallow, and is occupied by an oval rosette consisting of poorly developed radiating laminae.

An opening in the dorsal anterior part of the chamber leads into an ethmoidal accessory sac that lies, like that of the Turbot, upon the expanded head of the maxilla, reaching as far forward as the ethmo-premaxillary ligament.

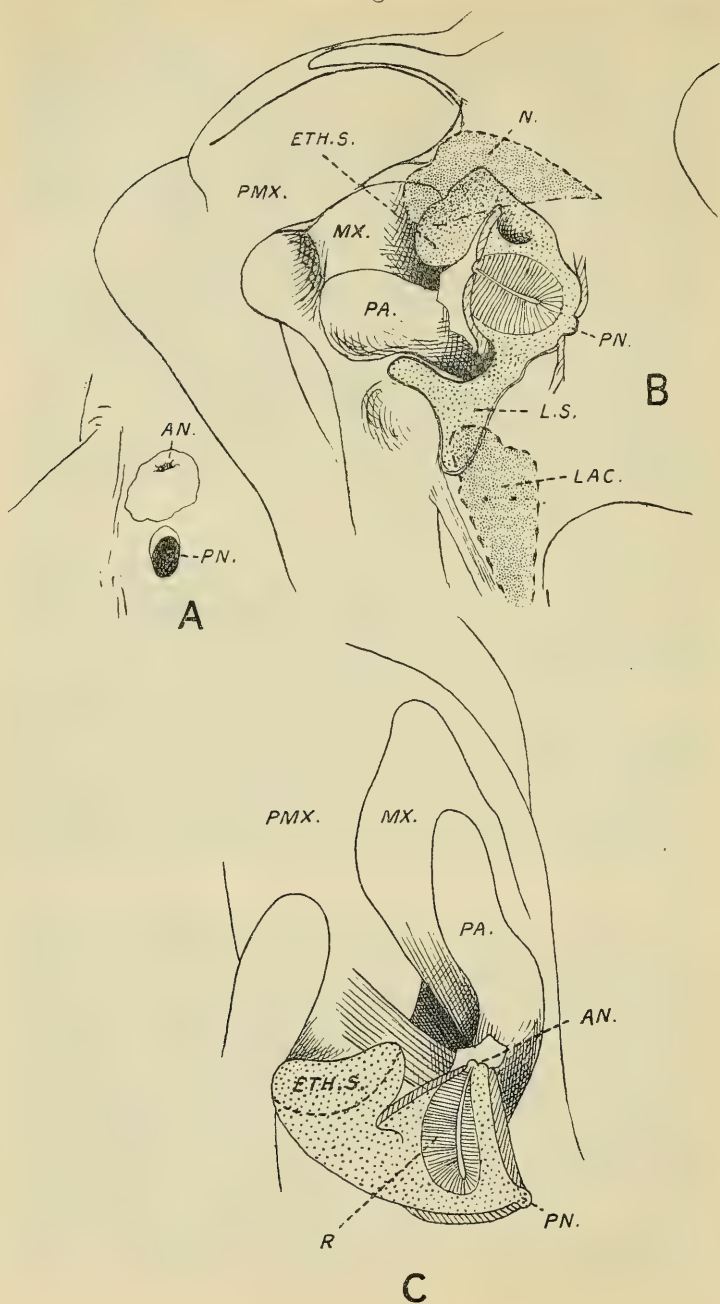
Upon the blind side the olfactory chamber is in connection with one accessory sac only, which corresponds in position and general relations to that upon the blind side of the Turbot.

*Solea vulgaris.*

The nostrils in this genus have been accurately described by Bateson and Miss Pereyaslawzeff, and Kyle also gives a brief notice of its accessory sacs.

Upon the eyed (right) side the lower wall of the olfactory organ is much contracted, so that the tubular nostrils are approximated, and both point almost directly backwards. The olfactory chamber is, however, of fair size, and is occupied by a long oval rosette with its axis nearly vertical (directed towards the centre of the left eye). The position of the rosette is evidently due to the backward rotation of the anterior nostril consequent upon the stunted growth of the ventral wall of the chamber referred to above. The laminae of the rosette lie mainly at right angles to a long central raphé, like those of the Eels; each has a gently convex free border.

Text-fig. 212.





Posterior to the rosette, just above the posterior nostril, is a clearly defined oval hole that leads into a two-lobed accessory sac. The lower and larger lobe runs backwards parallel to the margin of the mouth, swelling slightly towards its distal end. The upper lobe lies beneath the upper end of the rosette. These two lobes obviously represent the ethmoidal and lachrymal sacs of more normal genera.

Upon the blind (left) side, the nostrils are separated by a very considerable distance, due almost entirely to a tubular elongation of the nasal cavity between the rosette and the posterior nostril (cf. *Mullus*). Both nostrils are tubular, the anterior stout and bluntly conical, the posterior smaller and protected against ingress by the thinness of its converging lip. This nostril opens and shuts with a jerk synchronously with the respiratory movements (Bateson).

The rosette is similar in form to that of the right side, but lies with its length parallel to the internarial axis. It occupies only the anterior part of the nasal cavity; behind it a long tubular empty passage leads to the posterior nostril. The lower wall of this passage is dilated between the hinder limit of the rosette and the ethmo-lachrymal articulation to form a long accessory sac, that runs backwards and downwards with the adductor mandibulæ and palatine arcade superficial to it, giving off a small secondary diverticulum forward towards the lower end of the maxilla.

### Summary.

In considering the Zeorhombi, *Zeus* can be at once set aside as differing completely from the Pleuronectidæ in all the details of its nose structure.

The Pleuronectidæ examined can be separated into three groups.

1. *Hippoglossus* and *Pleuronectes*, in which the laminae of the rosette are disposed longitudinally.
2. *Rhombus* and *Arnoglossus*, with a flat, leaf-like lobe to the left anterior nostril.
3. *Solea*, with tubular nostrils and elongated Eel-like rosette.

In all the genera there are accessory sacs in connection with the olfactory chamber, which are comparable to the ethmoidal and lachrymal sacs found in other Acanthopterygians, although they differ in number according to the genus and the side of the face, and except in the *Sole* are more strongly developed on the ocular than on the blind side.

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### Explanation of Text-fig. 212 (see opposite).

#### *Rhombus maximus*.

- A. Nostrils of the blind (right) side.
- B. Olfactory organ of the ocular (left) side, in position.
- C. Olfactory organ of the blind side, in position, from above.

In *Hippoglossus* and *Pleuronectes* both sacs are present and well developed on both sides of the face. In *Rhombus* the lachrymal sac is absent on the blind side, and in *Arnoglossus* on both sides. In the Sole the lachrymal sac is more developed than the ethmoidal, and is present on both sides, being particularly large on the blind side, the ethmoidal sac, or rather an indication of it, occurring only on the ocular side.

#### SCLEROPAREI.

##### TRIGLIDÆ.

##### *Trigla hirundo.*

The nostrils lie in an area of soft skin surrounded by scutes, high up on the face, slightly more than halfway from the eye to the point of the snout. The anterior nostril is a small round aperture surrounded by a low tubular lip. The posterior is separated from it by a bridge some few millimetres in breadth, and has the form of a vertical slit valved against inflow by special membranous flaps attached to the inner surface of each of its lips.

The olfactory chamber occupies the usual position with regard to the bones of the face, being lodged in a hollow between the maxillary process of the palatine in front and the ethmo-lachrymal articulation. It contains a clearly defined oval rosette consisting of from thirty to forty laminae with gently convex free borders arranged as usual around a linear axis.

Above and below the rosette the nasal cavity is extended to form a pair of accessory sacs, which have the position and arrangement common to the lachrymal and ethmoid sacs of other Acanthopterygians. The lachrymal sac spreads out into the hatchet-shape presented by that of *Capros*, reaching in front to the maxilla, and backwards upon the jaw muscles. Both sacs are compressed by the bones of the jaws as the mouth is closed.

##### CYCLOPTERIDÆ.

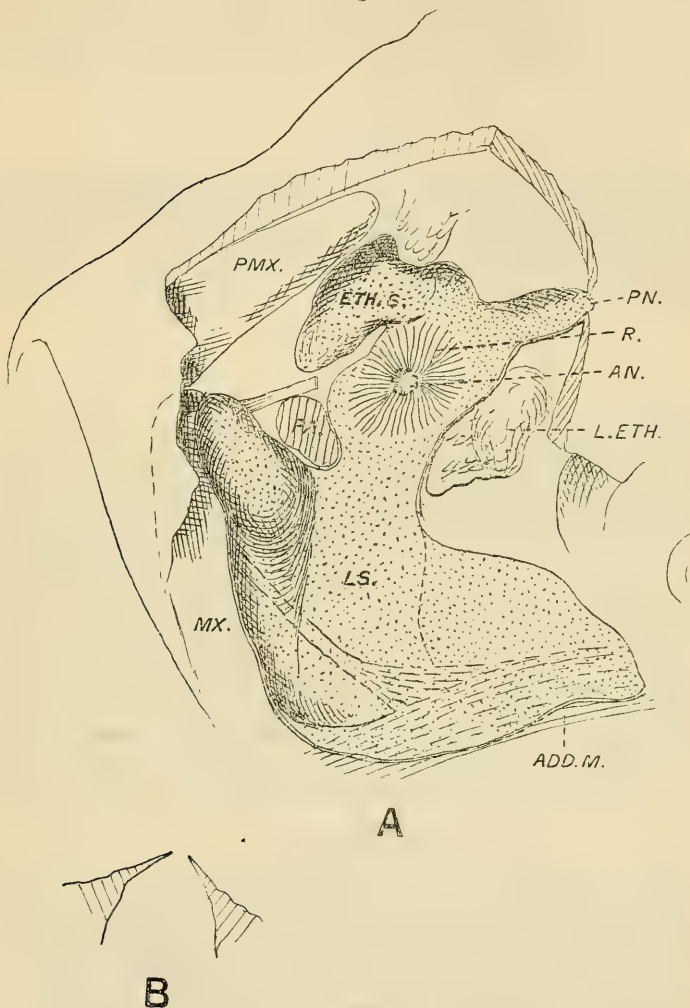
##### *Cyclopterus lumpus.*

The olfactory organ is in every way more extensive than that of *Trigla*. The nostrils lie very high up on the head, the anterior slightly in front of the eye above the level of its upper border, the posterior some considerable distance further back about halfway between the anterior border of the eye and the dorsal mid-line of the head. Both nostrils are circular, the anterior slightly the larger of the two, and situated at the end of a short conical tube; the posterior a mere pin-hole, valved against ingress by the thinness of its slightly protuberant lips.

The olfactory cavity is occupied by a circular rosette, consisting of about fifteen feeble laminae radiating from a central boss, which lies directly below the anterior nostril. The hinder part of the chamber is prolonged backwards as a smooth tubular passage to the posterior nostril (cf. *Mullus*, *Solea*), and above and below

the rosette is dilated to form two remarkably extensive accessory sacs similar to those of *Trigla* except in size. The lachrymal sac

Text-fig. 213.



*Cyclopterus lumpus*.

A. Left olfactory organ, in position.

B. Diagram of valvular posterior nostril.

in particular is of enormous size, extending forward beneath the head of the maxilla in front of the palatine, and backward along

the border of the maxilla and upon the adductor mandibulæ to a point below the eye.

It rests partly upon the palatine, but mainly upon the buccal membrane. Both sacs are strongly compressed by the bones of the upper jaw as the mouth is closed. The lachrymal sac probably is also directly affected by the swelling of the adductor mandibulæ, and the pressure of water against the buccal membrane during the act of expiration.

#### *Summary.*

Except in the presence of large ethmoidal and lachrymal sacs there is no very great resemblance between the olfactory organs of the above two representatives of the Scleroparei. The rosette in particular is very different, that of *Trigla* being of the normal oval type, and that of *Cyclopterus* rather of the type found in *Cottus* and *Bovichthys*.

### JUGULARES.

#### TRACHINIDÆ.

##### *Trachinus vipera.*

The nostrils lie close in front of the anterior border of the eye surrounded at some little distance by the lachrymal and nasal bones, and by the antorbital process of the ethmoid. Both are small, the anterior slightly tubed with a small posterior hood-like elevation, the posterior a vertical slit valved against ingress by thin protuberant lips. The bridge of skin between the two measures less than 2 mm.

The olfactory chamber lies directly below the nostrils, in the normal position as regards the deeper bones of the skull. It is occupied by a rosette of the normal oval type consisting of from fifteen to twenty sharply convex laminæ. Above the posterior end of the rosette is a clearly defined oval aperture leading into an ethmoidal accessory sac of normal type, which is compressed by the backward process of the premaxilla when the mouth is closed.

### NOTOTHENIIDÆ.

##### *Bovichthys variegatus.*

The nostrils lie in the posterior third of the distance between the upper part of the eye and the snout. The anterior is in the form of a short tube, the posterior is a vertical slit valved against the entry of water by the thinness of its backwardly directed anterior lip; between the two is a bridge of skin about 1 mm. in breadth. The rosette is circular and composed of nine swollen laminæ radiating from a central circular boss, which has no connection with the anterior nostril, as in most Fishes.

The olfactory chamber is expanded below and in front to form an extensive though shallow accessory sac which lies under cover of the lachrymal scute, and to a slight extent beneath the adductor



mandibulæ. It reaches in front into the angle between the maxillary process of the palatine and the maxilla, and is bounded internally by the buccal membrane. A small ethmoidal sac is also present, formed by an extension of the upper part of the olfactory chamber forwards around the backward process of the premaxilla.

The sacs are compressed by the premaxilla and maxilla as these bones move in the closure of the mouth.

### *Summary.*

In comparing these two representatives of the Jugulares the difference in the structure of the rosette should be particularly noticed. In *Bovichthys* this has the peculiar characters of that of *Cottus* (Blaue), while in *Trachinus* it is of the normal oval type.

## PEDICULATI.

### LOPHIIDÆ.

#### *Lophius piscatorius.*

The olfactory organ of *Lophius* has been described in detail by Miss Pereyaslawzeff, so that it is sufficient to mention that it is in a degenerate condition, consisting of only a small olfactory chamber set on the end of a short tentacle standing up from the dorsal surface of the face close behind the ethmo-palatine articulation.

The cavity of the chamber is filled by a few (four or five) sharply convex laminae set longitudinally parallel to one another. The olfactory nerve takes a most unusual course between the base of the olfactory tentacle and brain. It at first dips down between the ethmo-maxillary ligament and the raised outer border of the ethmoid, then passing outwards through this bone to the lateral surface of the cranium, runs backwards within the orbit between the roots of the oblique muscles, and finally enters the brain-case just in front of the origin of the recti.

### *Morphological Summary.*

The most important facts detailed in the above descriptions can be most clearly summarized in a table (pp. 656-7).

A consideration of the foregoing shows that the nose can be divided into two parts, one of which is practically constant and forms the essential part of the organ, while the other is of secondary importance, and may be present or not. These are the olfactory chamber with its rosette and the accessory nasal sacs.

The olfactory chamber differs comparatively little in shape and relative size, and in nearly every case occupies a constant and fixed position with regard to the bones of the skull, being lodged in a hollow in the ethmoid between its points of articulation with the palatine and the lachrymal bones. In nearly all cases it

	NOSTRILS.						ROSETTE.						NASAL SACS.					
	ANTERIOR.				Pos- TERIOR.		GENERAL FORM.				LAMINÆ.							
	Simple perforation.	Tubular.	With posterior hood.	With internal curtain.	Valved.	Open.	Oval with linear raphe.	Elongated.	Circular with central boss.	With laminae longitudinal.	With central linguiform process.	Linguiform process predominant.	Linguiform process absent.	Slight indefinite extension.	Posterior sac.	Ventral sac.	Dorsal sac.	Dorsal and ventral sacs.
Malacopterygii.																		
Salmo .....	N	...	N	N	...	N	R	...	...	...	...	L	...	...	s			
Osmerus .....	N	...	N	N	...	N	R	R	...	...	...	L	L	...	s			
Coregonus .....	...	N	...	N	N	...	R	R	...	...	...	L	L	...	s			
Clupea .....	...	N	...	N	...	N	R	R	...	...	...	L	L	...	s			
Chirocentrus .....	N	...	...	N	...	N	R	R	...	...	...	L		...				
Mormyrus .....	N	...	...	...	...	N	R	...	...	...	...		L	...				
Gymnarchus .....	...	N	N	...	...	N	R											
Ostariophysi.																		
Tinca .....	...	N	N	N	...	N	R	...	...	...	L	L	...	...				
Abramis .....	...	N	...	N	...	N	R	...	...	...	L	L	...	...				
Cobitis .....	...	N	N	N	...	N	R	...	...	...	L	L	...	...				
Labeo .....	...	N	N	N	...	N	R	...	...	...	L	L	...	...				
Clarias .....	...	N	...	...	N	...	R	...	...	...	L	...	...	...	...	s		
Malopterurus .....	...	N	N	...	N	...	R	...	...	...	...	...	...	s				
Pimelodus .....	...	N	...	...	...	N	R	R	...	...	...	...	...	s				
Silurus .....	...	N	...	...	N	...	R	...	...	...	...	L	...					
Gymnotus .....	...	N	...	...	...	N	R	...	...	...	...	L	...					
Apodes.																		
Anguilla .....	...	N	...	...	N	...	...	R	...	...								
Conger .....	...	N	...	...	N	...	...	R	...	...								
Muraena .....	...	N	...	...	N	...	...	R	...	...								
Haplomi.																		
Esox .....	N	...	...	N	...	N	...	R	...	...	...	L	L	...				
Scopelus .....	...	N	...	...	...	N	...	...	...	...	...	...	...	...				
Anableps .....	...	N	...	...	N	...	...	...	...	...	...	...	...	...			s	
Orestias .....	N	...	...	...	N	...	...	...	...	...	...	...	...	...			s	
Catosteomi.																		
Gastrosteus (Solger) .....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	s		
Fistularia .....	N	...	...	...	...	...	R	...	...	...	...	...	L	...	s			
Percesoces.																		
Belone .....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Hemirhamphus .....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Exocoëtus .....	...	N	N	...	N	...	R	...	...	R	...	...	L	...	...	...	...	s
Mugil .....	...	N	...	...	...	N	...	...	...	...	...	...	L	...	...	...	...	...
Ophiocephalus .....	...	N	...	...	...	N	...	...	...	...	...	...	L	...	...	...	...	...
Sphyræna .....	N	...	...	...	N	...	R	...	...	...	...	L	...	...	...	s		...
Anacanthini.																		
Gadus .....	...	N	N	...	...	N	R	...	...	...	L	L	...	s	...	...	...	...
Motella .....	...	N	...	...	...	N	R	R	...	...	L	...	...	s		s		...
Merluccius .....	N	...	...	...	...	N	R	...	...	...	L	...	...	...	...	s		...

	NOSTRILS.						ROSETTE.						NASAL SACS.					
	ANTERIOR.			POSTERIOR.			GENERAL FORM.			LAMINÆ.								
	Simple perforation.	Tubular.	With posterior hood.	With internal curtain.	Valved.	Open.	Oval with linear raphé.	Elongated.	Circular with central boss.	With laminae longitudinal.	With central linguiform process.	Linguiform process predominant.	Linguiform process absent.	Slight indefinite extension.	Posterior sac.	Ventral sac.	Dorsal sac.	Dorsal and ventral sacs.
Acanthopterygii.																		
Perciformes.																		
Perca .....	N	N	N			N	R	R			L	L						S
Latris .....	N	N				N	R	R			L	L						S
Beryx .....	N					N	R	R			L	L						S
Capros .....	N					N	R	R			L	L						S
Mullus .....	N				N		R	R			L	L						S
Pagellus .....	N				N		R				L	L						S
Scombriformes.																		
Scomber .....	N					N	R				L			S				
Zeorhombi.																		
Zeus .....	N	N				N	R				L	L			S			S
Hippoglossus .....	N	N	N			N			R		L							S
Pleuronectes .....	N	N	N		N		R		R									S
Rhombus .....	N	N	N			N	R								S			S
Arnoglossus .....	N					N												
Solea .....	N				N		R							S				S
Scleroparei.																		
Trigla .....	N				N		R				L	L						S
Cyclopterus .....	N				N			R			L	L						S
Jugulares.																		
Trachinus .....	N	N			N		R				L	L				S		
Bovichthys .....	N	N			N			R			L	L						S
Pediculati.																		
Lophius .....																		

opens to the exterior by two nostrils, and contains a rosette in which the component laminae are as a rule set radially around the sides and hinder end of an axis which is attached in front to the anterior wall of the anterior nostril (Rosette, Column 1).

An olfactory organ of this description occurs in most of the lower Teleosteans, and is well represented in a generalized condition in the Haddock, which, therefore, serves as a good central type with which to compare the rest.

Minor variations occur to different degrees in all parts—in the details of the nostrils, of the rosette, and of the cavity, some of

which appear to be characteristic of families or even larger groups.

The nostrils are perhaps the most variable part, and also that in which variation is correlated least with natural affinities.

The position of the anterior nostril directly above the rosette is almost universal, no doubt in order that the incurrent water may play directly upon the olfactory membrane. This position is also probably due in part to the close connection that there is in almost every instance between the axis of the rosette and the front lip of the nostril, which indicates that the rosette belongs essentially to the anterior part of the olfactory chamber. When the rosette is elongated, as in the Eels, Siluroids, and some Pleuronectids (Rosette, Column II.) the nostril opens in front of and not above it.

The anterior nostril is very frequently, especially in the lower Teleostei, more or less tubular (Nostrils, Column II.). The tube is particularly well marked in the Eels, some Siluroids, *Anableps*, and *Ophiocephalus*, but the tendency towards tube-formation is so widely distributed and variable in its occurrence and extent that it probably has little to do with natural affinity.

In certain groups, notably the Cyprinidæ and Gadidæ, the hinder wall of the tube is elevated to form a valvular flap (Nostrils, Column III.), and in other groups or separate genera (*Merluccius*, *Esox*, Salmonidæ, Clupeidæ) this may be augmented or replaced by a similar downward prolongation or curtain that dips into the olfactory cavity above the centre of the rosette (Nostrils, Column IV.). Both these developments of the bridge of skin between the nostrils are without doubt mainly of physiological importance, although in restricted groups (*e. g.* Cyprinidæ) they are also constant enough in their occurrence to be of systematic importance.

Variations in the form of the posterior nostril seem also to depend little upon affinity.

Broadly speaking this nostril is either a simple open perforation flush with the surface of the skin (Nostrils, Column VI.), which may show considerable differences in size, but commonly is either circular, oval, or crescentic in shape; or it is a slit or pin-hole closed by valves.

The crescentic type is highly characteristic of the Salmons, Herrings, and Carps, though found also in *Merluccius*, *Esox*, and (in a bean-shape) in *Zeus*. It always more or less closely embraces the hinder margin of the anterior nostril.

The oval or circular form occurs in many groups, but can hardly be regarded as characteristic of any.

A valved condition (Nostrils, Column V.) is found chiefly though not solely (some Siluroids) in fishes provided with accessory nasal sacs, and forms part of a general mechanism for drawing water forcibly into the olfactory chamber through the anterior nostril. In their simplest condition the valves are merely the thin converging lips of a minute perforation at the end of a short



conical tube (*Solea*, *Cyclopterus*, *Trachinus*), or the thin backwardly directed anterior lip of a slit-like orifice (*Mugil*, *Sphyræna*, *Scomber*, *Bovichthys*), but when fully developed they are special folds of membrane attached to the inner surface of one or both lips of the nostril and directed outwards (*Trigla*, *Pagellus*, *Anableps*, *Orestias*, *Clarias*).

Finally, there are cases in which there is one nostril only present [*Gastrosteus* (Solger); Chromidæ, Labridæ (Milne-Edwards)]. Or the nose may assume (apparently as a secondary modification) the condition of a widely open pit without defined nostrils at all (Scombresocidæ); or by the elevation of its floor and the subsequent rupture of the bridge between the nostrils, the cavity may be everted and the organ transformed to a bifoliate tentacle (Tetrodons, Wiedersheim and Tate Regan).

Turning now to the rosette, it is noticeable that the axis is most frequently linear and continued to the front lip of the anterior nostril, as in the Haddock, the rosette being usually of an oval form (Bateson's type 3) (Rosette, Column I.).

In *Cyclopterus*, *Bovichthys*, *Cottus*, *Esox*, *Orestias*, it is a central circular boss from which the laminæ radiate in all directions, the rosette being circular (Bateson's type 3) (Rosette, Column III.).

In the Eels, and to a less extent in the Siluroids and the Sole, the axis is lengthened and the laminæ are set in parallel series at right angles to it (Bateson's type 2) (Rosette, Column II.); and finally in *Ophiocephalus*, *Hippoglossus*, and *Pleuronectes*, the axis lies transverse to the internarial line and the laminæ are attached to its posterior border in parallel series (Bateson's type 4).

In the degenerate nose of *Lophius* the few laminæ left are also arranged parallel to one another and to the narial axis, and in the *Percesoces* laminæ are entirely wanting.

Considerable differences are apparent in the shape of the individual laminæ of the rosette. Starting from the type presented by *Gadus* as a centre (Rosette, Column V.), one line of variation leads by the suppression of the peripheral part of the lamina and the exaggeration of the linguiform process (Rosette, Column VI.) to the claw-like shape which is particularly characteristic of the rosette of the Salmonidæ and Clupeidæ. A similar though less pronounced modification is shown by the sharply convex laminæ of *Mugil*, *Perca*, *Pagellus*, or *Sphyræna*, and probably the triangular laminæ of the Eels should be included in the same series. On the other hand, suppression of the linguiform process (Rosette, Column VII.) gives rise to a gently curved or straight free border such as that seen in *Mormyrus*, *Clarias*, *Esox*, *Orestias*, some *Pleuronectids*, *Ophiocephalus*, *Bovichthys*, *Trigla*, and *Cyclopterus*. Except in the case of the Salmons and Herrings the form of the laminæ has apparently little dependence on natural affinity, except in quite closely related forms.

Variations in the position of the olfactory chamber relative to the framework of the face are very exceptional, being found only in *Motella*, *Zeus*, and *Lophius*. Its shape also is very constant,

and corresponds roughly to that of the rosette. In some genera the cavity is extended to an appreciable extent beyond the rosette (especially posteriorly) forming an empty space (Nasal sacs, Column I.), which in many genera undergoes further development to form a definite sac or sacs accessory to the true olfactory chamber.

The accessory sacs can be separated for convenience into three series. (1) A single sac directed anteriorly from either above or below the rosette (Nasal sacs, Columns III. & IV.). (2) A single sac directed posteriorly towards the orbit (Nasal sacs, Column II.). (3) Two sacs (ethmoidal and lachrymal nasal sacs) with very definite relations to the ethmoidal and lachrymal regions of the face, and constant also in their point of entry into the olfactory chamber above and below the hinder end of the rosette (Nasal sacs, Column V.). With regard to the two sacs of the third group there is not much doubt that they are homologous in the different genera in which they occur, but in the case of the sacs grouped in Series I. it is very difficult to determine how far they are homologous among themselves or to either of the sacs in Series III. In some cases (*Orestias*, *Anableps*, *Ophiocephalus*, *Trachinus*) the sac is possibly homologous with the ethmoidal sac, in others (*Gastrosteus* (Solger), *Solea*) with the lachrymal, having regard to its position, and especially to its mode and point of connection with the olfactory chamber; but in other cases (*Merluccius*, *Zeus*, *Sphyræna*, *Clarias*) the protrusion is of too general a character to render the homology anything more than very doubtful.

The backwardly directed sacs of the Salmons, Herrings, and the Mackerel (Series II.) being little more than a general protrusion of the hinder part of the olfactory chamber, should probably not in any way be regarded as homologous with either of the sacs of Series III. Their distribution is interesting, being restricted to fishes in which there is a great development of mucoid tissue about the eye and face, giving rise to a third eyelid against the base of which the sac abuts.

The two sacs in Series III. are found in their typical form, with one exception, in the Acanthopterygii. The exception is *Mugil*, which it should be noticed is in Günther's system of classification included among the Acanthopterygii. Upon the other hand, the presence of these sacs in the Pleuronectidæ appears to lend further justification for the removal of these Fishes from close proximity to the Gadids (Günther) to the Acanthopterygii (Boulenger).

The least specialized form of the olfactory organ is undoubtedly the rosette-filled hollow found in most of the non-Acanthopterygian fishes (Physostomi, Günther). From this as a starting point we may justly assume that the development of accessory sacs commenced with a general expansion of the parts of the olfactory chamber around the rosette, such as we find in *Motella*, and in a slightly more accentuated form in *Gymnarchus*, the Siluroids, and *Fistularia*.

Further specialization can be seen in the Salmon and Herrings, where the sac, though still a general extension of a great part of the olfactory chamber, is definite in shape, and enters into functional relations with the skeleton of the jaws. The next stage is shown by *Orestias*, *Ophiocephalus*, *Anableps*, *Bovichthys*, the opening of the sac becoming restricted to a definite circumscribed hole in a fairly definite and constant position in the wall of the olfactory chamber. Finally, the position and number of the sacs and their mode of connection with the olfactory chamber became crystallized in the Acanthopterygii, resulting in the definite ethmoidal and lachrymal sacs more or less characteristic of this group.

In certain fishes the accessory sacs have apparently been further specialized for the production of mucus. This point has been specially dealt with by Kyle in the case of Pleuronectids. To the fishes mentioned by him should be added *Merluccius* and *Zeus*, in both of which the accessory sac and olfactory chamber were filled with an abundance of coagulated mucus.

#### *Physiological Summary.*

From our knowledge of the structure of the olfactory organ, it may be concluded that there are at least three means by which a current of water may be brought to play upon the laminae of the rosette. The first is by the action of cilia within the anterior nostril and upon the lining membrane of the olfactory chamber (Bateson, p. 230). This seems to be the only way in the Eels, which are among the few fishes shown by Bateson to hunt their food by smell, and is probably also in many other cases one of the agents, though not the most important, in ensuring a constant gentle flow of water over the rosette.

The second method is by the deflection of water into the nose-cavity during forward progression. This may be effected by the position and slope of wide-open nostrils to the horizontal, as in *Esox*, but more frequently it is brought about by a hood or screen upstanding behind the anterior nostril (Gadids, Carps). In this case the force of the current is under the control of the fish, and varies directly with the pace at which it is moving. In noses of this type a further refinement is frequently met with in the form of an internal flap that conducts the water-current right down into the centre of the rosette.

The third method is by the alternate dilatation and compression of accessory sacs connected usually with the hinder part of the olfactory chamber.

In the majority of cases these are acted upon by the movements of the premaxilla and maxilla, occasionally (*Capros*, *Clupea*) by those of the mandible, or (Siluroids) of the palatine bar, and in several cases (where the lachrymal sac extends upon the buccal membrane) by the general pressure of the water in the mouth during expiration.

The currents produced normally by these sacs are rhythmical \*, flowing in and out of the nose as the fish gently opens and closes its mouth in breathing, and may be compared to the air-currents in the Mammalian nose during ordinary respiration. The strength of the current must, however, be quite under the control of the fish, for sudden and energetic movements of the jaws would naturally produce corresponding sudden and strong currents in the nose, comparable to a sniff. In noses of this class it is generally arranged by means of valves that the water shall enter by the anterior nostril and leave by the posterior.

A study of the anatomy of these parts leaves little doubt that their action is somewhat as stated above, but the facts detailed by Bateson from direct observation of the living fish make it difficult to account for the presence of these different and often elaborate mechanical devices. He states, and his experiments are quite conclusive, that practically all Teleostei seek their food by sight, and apparently have no appreciation whatever of what we term smells, so that it still remains an open question what their olfactory organ is sensitive to, and what part in their economy it fills.

Apart from the essential structural identity of the fish olfactory organ with that of higher Vertebrates, the mechanisms by which the surrounding medium is brought to play upon their sensitive membranes gently or violently at will are so closely analogous that one would be almost compelled to regard their functions as also essentially the same, did not Bateson's observations prove beyond question that the sense of smell in the ordinary sense of the word is absent in the vast majority of fishes, and it is to be noticed that it is just in those cases where it is absent that the mechanisms for regulating the water-currents within the nose are the most efficient.

It should, on the other hand, be observed that in a large number of the more highly specialized fishes there is a close connection between the nasal water-currents and the respiratory movements of the jaws, a fact that suggests that the nose may have more to do with respiration than with the discrimination of food, and possibly may be of some use in testing the water used for respiration.

#### *The Relation between the Structure of the Nose and General Habit.*

Although it is difficult to obtain accurate information concerning the habits of sea-fishes, enough can be ascertained (Day's 'British Fishes,' Cunningham's 'Marketable Fishes,' &c.) to roughly group

\* In many fishes (Bateson, *l.c.* p. 230) oscillating currents keeping time with the movements of the jaws in respiration have been directly observed, but they are not a necessary result of these movements, for although under normal conditions the two go together, the current may stop while the respiratory movements continue. Whether this depends upon a voluntary closure of the nostrils or what its explanation may be there is at present no evidence to show.

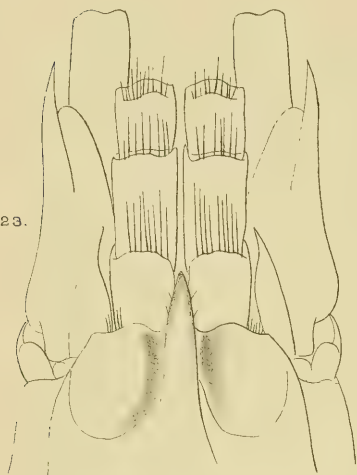




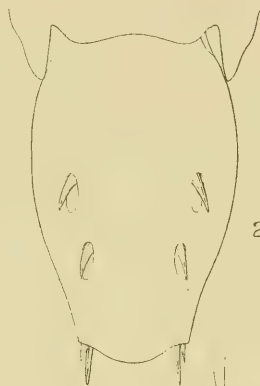
3. x 8 1/4.



1. x 23.



2. x 23.



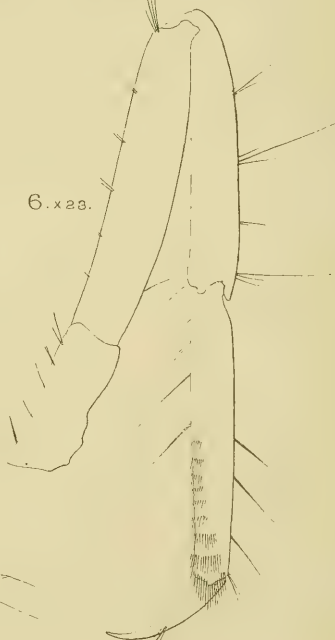
4. x 8 1/2.



5. x 11.



6. x 23.



the fishes dealt with in this paper into Bottom Fishes, Sluggish Shallow-water Fishes, and Free-swimming Open-water Fishes.

When tabulated thus there is seen to be practically no connection between the structure of the nose, particularly as regards the presence or absence of accessory sacs, and the general life-habit. Thus fishes of all habits may have accessory sacs (*Mullus*, Pleuronectids, *Scomber*, Herrings, Perch), or not (Eels, some Siluroids, Carps, Pike, *Scopelus*, *Gadus*, *Exocoetus*). This is a conclusion somewhat at variance with Kyle's generalization, that accessory sacs are characteristic of bottom or sluggish fishes as opposed to free-swimming forms and are in the main adaptive structures determined by habit.

On the contrary, it would appear from the above that they are rather part of a general advance in structure, and belong, at least in their most characteristic development, to families that have reached the highest all-round development.

#### EXPLANATION OF ABBREVIATIONS IN THE TEXT-FIGURES.

A.N., anterior nostril. ADD.M., adductor mandibulæ. AOR., antorbital scutes. AX., axis of rosette; AX.', its connection with lip of anterior nostril. B.M., buccal membrane. C., central segment of lamina. CT., curtain-like extension of bridge between nostrils. E., eye. E.MX.L., ethmo-maxillary ligament. ETH.P.A., ethmo-palatine articulation. ETH.S., ethmoidal nasal sac. FR., frontal. H., hood-like process of posterior lip of anterior nostril. L., linguiform process of lamina. LAC., lachrymal scute. L.ETH., lateral ethmoid; L.ETH.', its articular process for the lachrymal. LM., lamina. L.S., lachrymal nasal sac. MD., mandible. METH., mesethmoid. MX., maxilla. N., nasal. N.S., nasal sac. OL.B., olfactory bulb. OL.C., olfactory cavity. OL.N., olfactory nerve. P., peripheral segment of lamina. PA., palatine. PMX., premaxilla; P.MX.A., palato-maxillary articulation. P.PMX.L., palato-premaxillary ligament. P.N., posterior nares. R., rosette. R.MX., retractor maxillæ. R.PMX., retractor premaxillæ. T., tentacle.

#### 4. Description of a new Species of the Genus *Alpheus* Fabr. from the Bay of Batavia. By J. G. DE MAN \*.

[Received April 30, 1909.]

(Plate LXX. †)

ALPHEUS EHLERSII, sp. n.

Syn.: *Alpheus macrochirus* de Man, in Archiv für Naturg. 53 Jahrg. (Berlin, 1888), p. 519.

A re-examination of the two specimens of *Alpheus* from the island of Edam, Bay of Batavia, described by me (*l. c.*) under the name of *A. macrochirus* Richters, not only proved that they had been wrongly referred to that species, but also that they are the representatives of a hitherto unknown form. This new species, which I have the pleasure to dedicate to Professor Ehlers of

\* Communicated by R. I. Pocock, F.L.S., F.Z.S.

† For explanation of the Plate see p. 666.

Göttingen, who kindly enabled me to study the two specimens, apparently belongs to the group "*insignis*" of Coutière and is most closely related to *A. paracrinitus* Miers, to *A. paracrinitus* Miers, var. *bengalensis* Cout., and to *A. lanceoloti* Cout., three species inhabiting the Maldives and Laccadive Archipelagoes, though the first of them was originally discovered at Goree Island, Senegambia.

The larger specimen is 16.5 mm. long, the other 15 mm.

Rostrum acute, reaching to the distal fourth of the visible part of basal antennular article; rostral carina obtuse, extending backward to the base of the rounded, unarmed, orbital hoods, from which it is separated by rather deep, though narrow grooves. On each side of the rostrum, the frontal margin (Pl. LXX. fig. 1) bears a rounded prominence, nearly as in *A. superciliaris*, but glabrous and with the outer margin more oblique. Antennal and antennular peduncles with spines and appendages nearly as in *A. paracrinitus bengalensis* (Coutière, Alpheidae Mald. and Laccad. Archip. 1905, pl. lxxxii. fig. 37). Second antennular article once and a half longer than wide distally, a little longer than the visible part of the 1st and of the 3rd, which are of equal length; stylocerite acuminate, reaching to the second fourth part of median article. Carpocerite surpassing the antennule almost by the whole length of 3rd article; the terminal spine of the scaphocerite, the outer margin of which is slightly concave, is slightly curved inward and reaches almost to midway between the extremities of both peduncles; the terminal spine exceeds by a little more than one third of its length the tip of the scale, which is a little shorter than the inner peduncle. Basicerite with a small spine on the lower side, not visible from above. Telson (Pl. LXX. fig. 2) nearly as in *A. paracrinitus* var. *bengalensis*, but the outer angles of the slightly prominent posterior margin obtuse. The length of the telson equals in both specimens 3.1 times the width of the posterior margin; the greatest width anteriorly is, in the larger specimen, 1.93 times, in the other just twice the width of posterior margin; in both specimens the spinules of the upper surface, which are 0.2 mm. long, are situated as in the var. *bengalensis* of *A. paracrinitus*, the anterior pair anterior to the middle, the proportion between the length of the telson and the distance of that pair from the posterior margin being, in the larger specimen, 1.73, in the other 1.85; the proportion between the distances of both pairs of spinules from the posterior margin is, in the larger specimen, 1.6, in the other 1.7.

Meropodite of larger chelipede twice as long as wide; upper margin unarmed at its extremity, infero-internal margin with a small acute tooth at the apex and with seven small movable spinules, 0.117 mm. long, inserted from the proximal extremity to the distal third. Chela 8.4 mm. long, one third longer than the carapace, 2.8 times longer than high, and somewhat compressed, its thickness being in proportion to the height as 2.3; upper and lower borders of the palm (Pl. LXX. fig. 3) nearly parallel, lower border



rounded, slightly concave at the base of the immobile finger, though not emarginate or notched; upper border also rounded, but presenting, just behind the truncate distal extremity of the palm, a narrow groove, running obliquely inward, though not continued on to the inner surface of the palm; this groove (Pl. LXX. fig. 3) runs parallel with the oblique anterior end of the elliptical area. The dactylus, a little longer than the immobile finger, measures almost one third of the palm and almost one fourth of the whole length of the chela; the palm is sparsely though distinctly punctate, the inner surface anteriorly, like that of the immobile finger, hairy, the outer surface of the latter longitudinally grooved. But for the oblique groove on the upper border, the larger chela much resembles that of *A. paracrinatus* var. *bengalensis*.

Meropodite of smaller chelipede like that of the larger, but the infero-internal margin, though also with a small acute tooth at the extremity, with only four or five movable spinules. Chela 5.55 mm. long, the larger chela once and a half as long as the other; the smaller chela (Pl. LXX. fig. 4), the fingers of which are about as long as the palm, is 3.7 times longer than high, the palm twice as long as high, with the upper border entire and rounded, like the lower.

Meropodite of 2nd legs in the larger specimen 6 times, in the other 6.85 times, longer than wide. In the larger specimen the 1st carpal segment, 5.3 times longer than thick, is just twice as long as the 2nd, the 2nd twice as long as the 3rd and as the 4th, which are of equal length, and the 5th a little shorter than the 2nd; the chela, the fingers of which are a little longer than the palm, is almost twice as long as the 5th segment. In the other specimen (Pl. LXX. fig. 5) the 1st carpal segment, 6.3 times longer than thick, appears 2.44 times longer than the 2nd, and the 2nd, which is slightly shorter than the 3rd and the 4th taken together, is as long as the 5th; the chela, finally, the fingers of which are slightly longer than the palm, is 1.8 times longer than the 5th segment.

The proportions of the 5th pair (Pl. LXX. fig. 6) are: Carpus 1; meropodite 1.18; propodite 1.07. Meropodite 5.2 times, carpus 6 times, propodite 7 times longer than wide, these members with rather long setæ, and the propodite with the usual bristles; dactylus, as in *A. paracrinatus*, tapering, acuminate, 4 times as long as wide at its base, slightly curved, simple, without any trace of a secondary claw, and measuring just two-fifths of the propodite.

Unfortunately the legs of the 3rd and 4th pairs are absent in both specimens, except one leg of the 4th pair in the younger individual; the meropodite is quite unarmed, the propodite carries 6 spinules, and the simple dactylus agrees with that of the 5th legs.

*Alpheus paracrinatus* Miers differs by the upper border of the larger chela being entire, without a groove, by the different shape of rostrum and frontal margin, by the shorter stylocerite, and probably by other characters; *A. lanceoloti* is a more different species; and *A. macrochirus* Richters, finally, differs at first sight by the flattened, triangular rostrum, by the longitudinal groove

on the upper border of the larger chela, there being here no transverse groove, by the stouter shape of the smaller chela, by the dactyli of the 3rd and following legs being armed with two accessory claws, etc.

## EXPLANATION OF PLATE LXX.

*Alpheus ehlersii*.

Fig. 1. Frontal and antennal region of the larger specimen,  $\times 23$ .

Fig. 2. Telson of the same,  $\times 23$ .

Fig. 3. Larger chela and carpus of the larger specimen looked at from the inner side,  $\times 8\frac{1}{2}$ .

Fig. 4. Smaller chelipede of the same,  $\times 8\frac{1}{2}$ .

Fig. 5. Second leg of the younger specimen,  $\times 11$ .

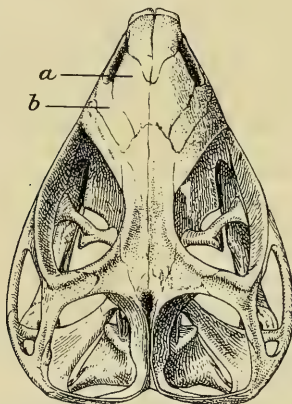
Fig. 6. Fifth leg of the larger specimen,  $\times 23$ .

June 15, 1909.

Dr. A. SMITH WOODWARD, F.R.S., Vice-President,  
in the Chair.

Mr. H. W. Unthank, F.Z.S., exhibited a skull of *Sphenodon* with two bones on each side in the nasal region, and made the

Text-fig. 214.



*Sphenodon* skull with abnormal nasal region.

a. Left median bone in nasal region.

b. Left external bone in nasal region.

following remarks:—"In place of the usual single nasal on each side there appear to be two bones, one near the median line, the other more external, the line of division running from before

backwards (text-fig. 214). On sawing across the middle of the nasal region the anterior part of the median pair of bones came away with the premaxillæ and vomers, leaving the external bones *in situ*. These show bevelled inner edges where they were slightly overlapped by the median bones, so that the surface-marking is that of a suture in the middle of what is usually a single nasal bone."

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*The Ears of an Elephant from British East Africa.*

The Secretary exhibited the ears of an Elephant shot by Mr. Sutton Timmis, F.Z.S., on the Guaso Ngishu Plateau, east of Mt. Elgon, British East Africa. The ears of this elephant (text-fig. 215) were elongated vertically, with an arched upper

Text-fig. 215.



Right ear of an Elephant (*Elephas africanus peeli*) from the Guaso Ngishu Plateau, British East Africa, from a specimen shot by, and in the possession of, Mr. Sutton Timmis, F.Z.S.

border, and a long, relatively narrow, and pointed lappet. The general shape corresponded closely with that of the ears of the elephant from the Aberdare Mountains, British East Africa, figured by R. Lydekker (P. Z. S. 1907, p. 393, text-fig. 114). The vertical length (4 feet 9 inches) and the greatest breadth

{3 feet 2 inches) were greater than the corresponding dimensions of Mr. Peel's specimen, described by Mr. Lydekker, and the ear was relatively not quite so narrow, but the general formation was closely similar. This new example confirmed Mr. Lydekker's diagnosis of *E. a. peeli*.

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Mr. J. C. White, C.I.E., C.M.Z.S., exhibited photographs of a living specimen of a young Takin (*Budorcas*) from Ghassa, N.W. Bhutan. The photograph (text-fig. 216) had been taken on board ship at Calcutta and the animal was to be presented to

Text-fig. 216.



Young male Takin (*Budorcas taxicolor whitei*).

the Society. The Secretary added that he had ascertained that the Takin had reached Genoa in good condition and might be expected at the Gardens about June 21st. It was the first Takin that had reached Europe alive.

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On behalf of Mr. R. Lydekker the Secretary exhibited photographs of a spotted bull Tsaine or Bantin shot by Mr. Arthur Porter in the great forest of Siam in November 1908. The tawny-coloured hair of this bull is flecked all over with small



white spots, as is shown not only in the photograph (text-fig. 217), but by a piece of the hide presented by Mr. Porter to the British Museum. When noticing this animal in 'The Field' newspaper Mr. Lydekker suggested that the spotting might be a "sport," or due to senility; but since that date a second spotted Tsaine has been killed by Mr. Elwes, a friend of Mr. Porter, in the same forest. This considerably alters the case, although there is no

Text-fig. 217.



Spotted Bull Tsaine from Siam, photographed by Mr. Elwes.

information as to whether all adult male Siamese Tsaine are flecked with white. As no such flecking has been recorded in Burmese Tsaine (*Bos sondaicus birmanicus*), Mr. Lydekker ventured to provisionally propose the name *B. sondaicus porteri* for the Siamese Tsaine, taking the piece of hide in the British Museum as the type.

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*A new Rat from Guatemala.\**

Mr. Oldfield Thomas, F.R.S., F.Z.S., exhibited specimens of a new Rat which had been obtained by Mr. G. C. Shortridge during the collecting trip to Central America on which he had been

\* [The complete account of this new species appears here, but the name and a preliminary diagnosis were published in the 'Abstract,' No. 73 (June 15, 1909).—EDITOR.]

recently sent by the Society. The trip had been mainly organized to obtain live animals, but it had been a definite part of Mr. Shortridge's duties to collect what study-specimens he could, and these had now been presented to the National Museum by the Society.

The species was described as follows :—

OTOTYLOMYS GUATEMALÆ.

Thos. Abstr. P. Z. S. 1909, p. 32 (June 15).

Allied to *O. phyllotis*, but considerably larger.

Fur soft and fine. General colour above uniform greyish-brown (rather browner than "mouse-grey"); back darkened by black-tipped hairs. Under surface white, not sharply defined laterally, the majority of the hairs white to the roots, but down the centre of the chest and belly many have slaty bases. Ears not specially enlarged, naked, greyish. Hands and feet parti-coloured, the centre of the metapodials slaty-brown, their sides and the digits white; in *O. phyllotis* the whole of the hands and feet are white. Tail not so entirely naked as in the allied forms, as there are a few scattered hairs along its under surface; grey above, rather paler below, not contrasted or mottled.

Skull markedly larger in all dimensions than that of *O. phyllotis*, but showing all the characters used by Dr. Merriam to distinguish that animal from true *Tylomys*. The brain-case is, however, deeper and the palatal foramina are not so large.

Molars with a low but well-marked supplementary cingular ridge running transversely across in front of the anterior cusps, a structure also found in *O. phyllotis*, but not in *Tylomys*, nor, so far as I know, in any other genus of Cricetinae.

Dimensions of the type, measured in the flesh :—

Head and body 170 mm.; tail 161; hind foot (s. u.) 28; ear 16.

Skull—greatest length 40·7; basilar length 31·5; greatest breadth 20·5; nasals 15; interorbital breadth 6·7; breadth across parietal ridges 16·2; palatilar length 16·6; diastema 11; palatine foramina 8·1 × 3·5; length of upper molar series 6·8 (in another specimen 7·2).

*Hab.* Tucuru, Polochie R., about 50 miles E. of Coban, Guatemala.

*Type.* Adult female. B. M. no. 9.6.11.13. Original number 4. Collected 24 January, 1909, by G. C. Shortridge, and presented by the Zoological Society.

This species is at once distinguishable from *O. phyllotis* by its larger size, greyer colour, and parti-coloured feet, in which respects, as in its smaller palatine foramina, it tends to approach the members of *Tylomys*. It is smaller than *O. fumeus* Allen.

Mr. Thomas expressed his pleasure that the discovery of so marked a new form had resulted from the dispatch of Mr. Shortridge to Central America, and hoped that the Society would undertake many such expeditions in the future.

*The Coral Island Question.*

Dr. F. Wood Jones, F.Z.S., exhibited lantern-slides, models, and specimens to illustrate the formation of coral structures. The following is an abstract of his remarks :—

The full communication upon which the demonstration was based will be reproduced in its complete form elsewhere. The present note consists merely of a brief *résumé* of the problems requiring solution, a criticism of those theories already advanced, and a proposal of some new suggestions arising out of the study of the atoll of Cocos Keeling.

*(i.) The problems demanding explanation.*

A theory that is to be satisfactory must not be limited in its application to any one form of coral structure, but must account for the origin of all those forms of reef and island that are built up of coral. It must take notice not only of the larger land masses, and the more obvious geographical structures, but must embrace the actual growth tendencies of the coral colonies themselves, for it is merely by an aggregation of such colonies that these structures are made up. The submerged coral bank, the barrier reef, the fringing reef, and the atoll must all receive an adequate explanation; and this explanation must be compatible with the actual processes that may be observed to take place in the individual colonies of a reef.

In the case of the atoll—the most highly developed of all the coral structures—the theory must satisfactorily account for the presence, and development, of all the several parts that enter into its composition. Finally, no explanation must be considered as adequate that carries us only to the stage of the developed atoll, for it must also agree with, and account for, the tendencies of its known after-history.

The problems connected with the development of the atoll are to be correctly gauged only from a proper appreciation of the whole of its structure. The explaining of the origin of an extensive coral reef situated upon a large ocean plateau, the mere raised rim of which constitutes dry land, is a problem different from that involved in accounting for a ring of islands, when these islands are supposed to be the summit of an abruptly rising oceanic peak.

The question of the actual contour of the elevation of the ocean floor upon which the atoll itself takes origin, is a very important one; and, in the case of the Cocos Keelings, the soundings of the cable routes have accurately determined the true proportions of this island basis. In this case, the bank that rises from the bed of the ocean is by no means a steep one, and it is only the drop from the reef edge into comparatively trivial depths that may be termed at all abrupt. For the rest, the basis consists of a gradually shelving slope of Globigerina and Radiolarian ooze



which does not reach 3000 fathoms—or ocean depths—till over 100 miles are traversed from the atoll. The summit of this long ridge is composed of Globigerina ooze, and for ten miles from the reef edge—that is to a depth of 2000 fathoms—the gradient of the bank is 1 in 5. From this point on, to a distance of 50 miles from the reef, the slope is about 1 in 80, and then for the next 50 miles or so, at 1 in 100 to the ocean depths of Radiolarian ooze. The presence of this great bank of ooze demands an explanation. Upon this submarine plateau there is a coral-reef, and it is necessary to explain how the bank becomes a suitable site for coral growth—since we know that the bathymetrical range of reef-building corals is slight; and also to account for this limitation of the extension of reef-coral life in the depths of the sea.

We know that on such banks such reefs exist below the surface of the sea, and (from the soundings of Admiral Sir J. W. L. Wharton) we also know that, before they reach the surface, their margins are raised above the level of their central area. These are Darwin's "drowned atolls," and if his theory of the development of coral structures be not accepted, any new theory must take cognisance of these basin-shaped reefs. Another typical feature is the level plateau of coral breccia that forms the barrier reef and shore platform of the atoll, and that—although it does not appear to be recognized—runs uninterrupted beneath the surface of the islands, and outcrops upon the lagoon shore. To this whole platform of consolidated coral conglomerate I have given the name of the *Breccia Platform*, for its subdivision into barrier reef, shore platform, lagoon breccia, &c. is artificial, and ignores the fact that these parts are all in continuity, being really one level stratum upon which the islands rest as mere débris piles. The *Breccia Platform* of an atoll runs as a continuous structure round the whole extent of the ring, save where the lagoon entrance exists.

The origin of the *Breccia Platform* must be made clear, and its presence as a continuous layer beneath the surface of the islands needs explanation. It is the normal state of affairs for the entrance to the lagoon to be situated upon the lee side of the atoll and this requires explanation, as do also the facts that some atolls are perfect circles with no entrance to the lagoon, while some have a pseudo-entrance to the windward.

In some atolls, each constituent island of the ring is itself an atollon and encloses its own lagoonlet; in others, certain of the islands only become atollons, or some, or all, of the islands are crescent-shaped, and are only approximations to the circular form. These conditions are obviously the outcome of the actions of forces very similar to, or identical with, those that formed the parent atoll, and the explanation of its formation should also be applicable to the cases of the constituent islands.

Observations extending over a long period of time may be recorded of several atolls, and in these cases it is usual to find



that the lagoon tends to become steadily more shallow, while the actual growth of coral upon its bottom actually diminishes. In some cases, and in certain stages of atoll development, this change takes place rapidly, so that in the human history of the atoll great alterations have taken place in lagoon configuration. Again, the lagoons of many atollons, and of some atolls, become entirely obliterated and dry land joins island to island across the ring. The theory that furnishes an explanation for the origin of these structures must not be in opposition to this known fact of their after history. Some high oceanic islands possess a reef that surrounds their coast-line and is a mere outskirt to their land; while, in some cases, the reef stands out from the shore, and a channel of shallow water intervenes between the shore-line and the reef. These features must be accounted for, for the near-shore reef and the outstanding reef are evidently very similar formations to the reef that is seen as the seaward margin of the breccia platform of atolls.

Finally, colonies of *Porites*, and other corals of a massive habit of growth, tend, with their increase of size, to become first flattened at the top and then basin-shaped,—only the outer edge of the top of the colony being a raised rim of living coral. This formation is strangely like an atoll in miniature, and its development must be carefully studied.

(ii.) *The theories put forward to explain these problems and a discussion of some observed facts that tend to contradict them.*

(a) *The Theory of Subsidence*; first brought forward by Darwin in 1837 (Proc. Geol. Soc. vol. ii. p. 552). In this theory the sinking of the land basis was the cause of all the typical features of fully developed coral structures.

The oceanic bank is assumed to be the remains of old land sunk beneath the waves. The steps of development are as follows. An oceanic island is situated in a sea the conditions of which, such as constant temperature &c., permit the flourishing of the reef-building corals. The coral colonies grow around its shores wherever the submarine slope furnishes foothold within their bathymetrical range. The island becomes surrounded by a reef. The process of subsidence causes the island to sink slowly beneath the waves. The reef continues to grow upwards, especially at its outer edge, for Darwin said that better aeration by waves, and more abundant food, nourished the outer colonies; there is no compensation for the sinking land, and the island becomes surrounded by a moat, girt about by an outstanding coral-reef. The process goes on: the land finally sinks within, and the reef—upon which islands are afterwards developed—encloses a lagoon in which the original island has disappeared. Finally, when subsidence is too rapid for the upgrowth of the coral-reef to keep pace with it, the whole structure sinks beneath the waves as a reef with raised margins—

a "drowned atoll." The theory is wonderfully complete and embraces every form of coral structure. Many observed facts have, however, been accumulated since its first proposal, and many of these observations tend to make the theory untenable.

Atolls are known to exist on land areas actually rising—"high islands" and "low islands" exist in the same neighbourhood; and some atolls bear unmistakable signs in their own structure of actual elevation having taken place during their formation. (Semper.)

The undermining of trees and the denudation of shore-lines do not necessarily indicate subsidence, for they are inconstant effects, and an area of land denudation is compensated for by an area of land construction at another part of the island ring. The lagoon does not tend to become deeper as time goes on, nor do its shores tend to become constantly denuded by their sinking beneath the waves; but lagoons tend to shoal, and lagoon shores to encroach upon the waters of the lagoon. "Drowned atolls" are not necessarily final stages of atoll sinking, for they may be early stages of atoll making.

It is not to be assumed that subsidence, like a conflagration, obliterates its own evidences, for were subsidence to have been a factor in the formation of the Cocos atoll, the *Breccia Platform* would inevitably show its workings.

Since the outer edge of the *Breccia Platform* is the most recently formed part, and its inner edge is its most ancient part; and since, in its whole extent, it embraces portions laid down throughout an enormous period of time: it is evident that the level of its outer edge should be higher than that of its inner edge, if subsidence had occurred—and this is not found to be the case.

The fact that atolls tend to be elongated along the line in which the group to which they belong is stretched (Sollas, Brit. Ass. 1893) does not necessarily indicate that subsidence has caused the sinking of a long ridge of oceanic land, for since the wind has a great influence in atoll shaping (Kramer, Hedley, &c.), the wind that shapes the individual atoll tends to shape the whole group.

(b) *The Theory of Solution*; first brought forward by Sir John Murray in 1880 (Proc. Roy. Soc. Edin. April 5th, 1880). Between the date of the publication of Darwin's theory and the framing of this hypothesis, several new observations had been made, and some of these were of such a nature as to tend to disprove the earlier theory, and some of them greatly simplified the problem. It was known that banks did exist in the sea upon which reef-corals might conveniently start their building. This knowledge was not available in Darwin's time.

In Sir John Murray's hypothesis these banks are assumed to be probably volcanic in origin and to be afterwards clothed with *Globigerina*-ooze. The reef is formed upon the bank when the bank is of a convenient depth, and the corals of the outer edge grow more luxuriantly because they are better fed. The central parts

of the reef are gradually removed by solution of dead coral-rock owing to the action of carbonic acid gas dissolved in sea-water.

The lagoon is caused by the solution of the calcium carbonate of the coral colonies within its limits, and so the atoll shape is developed.

The existence of such banks in the open ocean is, of course, undoubted, but the evidence that they are all volcanic seems to be lacking: that they are clothed with *Globigerina*-ooze is well known from many observations.

That carbonic acid gas in sea-water can dissolve calcareous skeletons of coral colonies and other marine animals is a well ascertained fact, but that the process forms atoll lagoons is a mere hypothesis. The work of Murray, Irvine, and Ross shows that at greater depths the power of solution of sea-water is greater than at the surface: an explanation is therefore needed for the non-solution of the base of the island bank, while the process proceeds so rapidly at lesser depths as to form deep lagoons on its summit.

That calcareous matter suspended (but not dissolved) in the sea-water is swept in great quantities from lagoon *outlets* is true, as Sir John Murray observed; but it is also true that at the *inlets* it pours into the lagoon in such quantities that in Cocos atoll Dr. H. B. Guppy (himself an advocate of the solution theory) estimated that 5000 tons of sand and débris were washed in and deposited about the lagoon margins every year.

The deposition of calcareous matter carried in *suspension* in the water takes place more rapidly in the lagoon than does its removal. It is true that coconut palms are seen to overhang the waters of the lagoon as though the shore had been dissolved from about their roots: the fallacy of this argument has long been made evident when it is used as a support for the Theory of Subsidence, and is no less evident when urged to support the Theory of Solution. It is an accurate observation that the islets on a reef are commonly situated nearer to the lagoon shore than to the seaward edge, but this is the outcome of their method of making by the waves, and by the outward extension of the reef, and does not necessarily indicate that matter has been removed from within.

If it be granted that the waters of the lagoon might be specially favourable to the action of the processes of solution: it remains to be explained why the central portions of a reef, twenty fathoms under water, are dissolved more rapidly than are the outer margins. Until this explanation is supplied, basin-shaped reefs or "drowned atolls" do not become any easier to account for. The Solution Theory is urged to account for the formation of lagoons, and to explain how they become "widened and deepened"; but the widening and deepening of lagoons is contrary to experience, for narrowing and shallowing is the common fate of lagoons.

Granting that solution proceeds rapidly in lagoons, it still must be remembered that calcium carbonate is deposited from solution in large quantities within the lagoon area. Lagoon sandstone

is entirely a product of the lagoon, and so is the lagoon conglomerate; and both of these substances depend for their construction on the deposition of calcium carbonate around particles held in close contact. Again, fragments of dead colonies that are trundled up and down the lagoon shores by every tide, are commonly made more hard and more heavy by a rich deposit of calcium carbonate in the interstices of their structure. Finally, if solution of calcium carbonate is taking place within the confines of the lagoon, its action must be a feeble one, for in the Cocos lagoon are wide areas covered by dead coral colonies, killed, as we definitely know, in 1876; and these dead masses have resisted solution during the past 30 years.

(iii.) *Suggestions put forward by the Author to explain the development of Coral structures.*

As an outcome of observations made on the Cocos-Keeling atoll, it is suggested that the process of "Sedimentation" takes the largest share in the production of most of the stages of an atoll's history. The bed of the open ocean is composed of matter that has fallen from the surface; sedimentation is always taking place all over the ocean. In certain places, sometimes owing perhaps to the influence of oceanic currents, sometimes to the presence of an already existing elevation upon the ocean bottom, this sediment will tend to make ridges or banks. Many such banks are known to exist in the depths of the sea.

What may be the nature of the original elevation that has become covered by this deposit of Globigerina and Pteropod ooze, we do not know. Whatever their original nature they become essentially "Sedimentation" banks.

The question then arises as to where beneath the surface of the sea will the building of banks by sedimentation become arrested. The answer may be partly given by determining where wave action ceases to be felt below the surface of the sea, and the data to be derived from published observations on this point show the level to be somewhat inconstant. Its variability would be confidently expected, for waves vary enormously in their size and in their power to stir the underlying water. Yet we know that there is some point between the surface of the ocean and the bottom, above which the action of waves is felt and sediment will not come to rest in open ocean, and below which there is no wave stirring and sediment may rest and build banks and raise the ocean bottom. This point is considered important; and the plane in which this line of stasis occurs is named the *limiting line of sedimentation*. It is therefore to the *limiting line of sedimentation* that banks formed by sediment may be raised. A bank so raised would rise to such a plane, but could not go beyond it, for the wave motion would keep the particles moving, and thus level out the top of the bank and flatten it, so that it formed a plateau at the level of the *limiting line of sedimentation*. It is



claimed that the bathymetrical limit of the reef-building corals is intimately associated, if not coincident, with the *limiting line of sedimentation*, and that it is therefore a variable plane depending on the local conditions of the sea. The reasons for this coincidence are to be found in the study of the living corals themselves; and I have come to the conclusion that the presence of matter suspended in the water is the most potent factor in determining the unsuitability of an environment for coral life. Where sediment is at all times liable to fall upon the living zooids, reef-corals will not flourish: we would therefore not look for their luxuriant presence below the *limiting line of sedimentation*. In the wave-stirred area above this line, however, they can and do flourish. We therefore arrive at the presumption that sediment can build banks up to this hypothetical line, and reef-corals can build banks from this line up to the surface of the sea. There is therefore no reason why coral colonies should not settle upon the bank and start the development of a reef. As a matter of fact several other forms of life that possess calcareous skeletons outrun the reef-corals in bathymetrical range, and it is likely that they (calcareous algæ, deep water corals, &c.) first populate the summit of the bank.

The process now becomes less a matter for hypothesis and more one for actual observation, for the growth tendencies of reefs and of colonies may be more easily studied. It is claimed that the tendency is for such reefs to become "basin-shaped reefs," and to develop as flat banks, with edges raised from their general surface and abundantly covered with coral colonies. The chief factor in this process is again the action of sedimentation. The surface waters still drop their burden of suspended matter over the reef, and it is deposited upon the uneven surface of the coral colonies, for, though it could no longer come to rest upon the open sedimentation bank, it more easily finds a lodgment upon the broken coral surface of the reef. At the edges of the reef the sediment becomes more easily washed off by wave action, and the corals of the circumference of the reef flourish most.

To obtain a concrete picture of the process it is only necessary to turn to the colonies to be found any day in quiet pools in which sediment is accumulating. A colony of *Porites* grows as a spherical mass. In time it develops to such a size that its rounded upper surface becomes sufficiently flat to afford a lodgment for sediment. Then the activity of its central zooids wanes, and, by the upgrowth of the peripheral ones, the flattening increases. At length the central area dies—the zooids choked by sediment,—and a raised ring of active living zooids surrounds a central depressed area—an atoll in miniature.

That this process is not due to the colony reaching tide-level (Darwin, Semper) is proved by the abundant finding of such colonies developed many feet below the level to which the tide ever falls.

The process that may be seen any day in the myriad colonies

around an atoll, is presumed also to occur on the reef as a whole, for it is merely a question of substituting colonies for individual zooids to picture the development of the submerged basin-shaped reef.

The basin-shaped reef continues to grow upwards until tide limit arrests the growth of its margins. At this stage the waves begin to act upon it and hammer fragment against fragment with the production of a quantity of coral débris at the point of maximum intensity of the waves. This débris becomes cemented into solid breccia by the deposition of calcium carbonate around the particles that compose it. This is the beginning of the breccia platform, and its origin may be looked for upon the windward side; and on that side it will always remain best developed.

The breccia platform follows the raised rim of the reef in its development, and forms a level, solid, conglomerate crescent, upon which the waves break at low tide. Upon this platform some waves of unusual violence will hurl fragments broken from the reef margin, and these masses will be left stranded upon the platform when the force of the waves can trundle them no further.

This is the beginning of the island, and this process also may be expected to originate at the windward side and to be always most perfectly developed there. Any fragment thrown upon the breccia platform is potent to bring about an important change, for it initiates a process that may be seen anywhere when an obstacle is placed in the line of a current of water that carries any sediment in its stream. The current impinges on the impediment and its burden of sediment is deposited in stream lines from its extremities (Hadley and Dr. Guppy). In this way the form of the island tends to become that of a crescent.

The piling up of fragments will follow the line of the breccia platform, and so will take place as a part of the circumference of a circle or a horse-shoe. At the lee side, the waves will not have sufficient force to construct a breccia platform or pile débris upon it, so the lagoon entrance is situated upon this side. When the wind blows in opposite directions for two definite seasons, as in the Monsoon area, the action may be equalised all round the reef-edge, and so the atoll be a completed ring and each of its constituent islands be perfect atollons. In the Trade area, however, the uniformity of the wind will produce a horseshoe-shaped atoll, elongated in the line of the wind, with crescentic islands on its windward side. When the atoll structure is once developed, the enclosed lagoon tends to become the resting-place of a vast amount of sediment, formed by the disintegration of coral fragments by the force of the waves. The method of the deposition of this sediment is important.

As waves rush over the breccia platform in the intervals between adjacent islands, the current becomes slowed at the sides of the inlet, and sand is deposited in stream lines from the extremities of the islands, helping to increase more and more their crescent

form. In the middle of the interval between two islands the intruding current sweeps on farthest, and its burden of sand is dropped in the lagoon *opposite the gap in the island ring*.

This process accounts for the existence of those atolls that have the most land upon their leeward side, and an entrance *guarded by a breccia platform* upon their windward side. The sand swept in at their windward side is deposited upon the lee side of the lagoon (if it be a small one) and comes to rest in the original lagoon entrance. The entrance becomes blocked up, and a wide belt of land is formed upon the lee side of the atoll; but no barrier reef exists upon the lee side.

As sand is deposited in the lagoon it tends to obliterate the coral growth, and so a lagoon, that at first tended to become shallow by the upgrowth of coral colonies, ultimately becomes devoid of living coral, and to shoal entirely by the deposition of sediment. In the Cocos-Keeling atoll, the history since 1825 shows a steady filling-in of the lagoon. The continuation of the process that formed the perfect atoll, therefore, tends to obliterate the lagoon. The lagoon shores gain on the lagoon water, and banks rise up in its shallower parts; the windward side of the lagoon, if it be of large size, being the first portion to become obliterated.

The explanation of the origin of fringing reefs follows the same lines. On *any* platform that lies above the *limiting line of sedimentation*, reef-corals will develop, when the conditions of the water are suitable. Fringing reefs are merely reefs taking origin upon the submarine slopes of oceanic land, when these slopes afford a foothold in the wave-stirred area.

Barrier-reefs were explained in 1856 by Prof. Le Conte as being fringing reefs of which the growth was "limited on one side by the muddiness of the water, and on the other by the depth." In 1884 Dr. Guppy independently furnished the same explanation. This explanation, which is an isolated and discordant thing when "Subsidence" or "Solution" is taken as accounting for atoll formation, becomes of consequence, and falls into line with other ascertained facts, when the importance of "Sedimentation" is appreciated.

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Dr. R. Broom, C.M.Z.S., exhibited an unborn foetus of *Chrysochloris hottentota*, and two young specimens of *C. asiatica*, one probably only a couple of days old, and made some remarks on the habits and life-history of the Cape Moles.

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Dr. R. Broom, C.M.Z.S., also exhibited the skulls of two South African fossil reptiles—*Lycosuchus vanderrieti* and *Bauria cynops*. The former is from the Karroo Beds of Middle Permian age, and is the most perfect Therocephalian skull as yet discovered.

Since Owen's order Theriodontia was found to contain two well-

marked groups of mammal-like reptiles, it has become necessary to subdivide the group, forming either two new orders or two sub-orders. The older group, which is confined to Permian beds, has a single occipital condyle and a Rhynchocephalian palate, and has been named Therocephalia. The other group, which is restricted to Upper Triassic beds, has two occipital condyles and a mammal-like secondary palate, and usually complex molars. This group should retain Owen's original name Cynodontia. Doubtless the later group is descended from the earlier, and *Bauria*, though a Cynodont, to some extent forms a connecting link. The Cynodonts are of exceptional interest, as there is little doubt the mammals have arisen from one of the members.

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The following papers were read:—

1. On the Organ of Jacobson in *Orycteropus*.

By R. BROOM, D.Sc., C.M.Z.S.

[Received June 3, 1909.]

(Plate LXXI.\*)

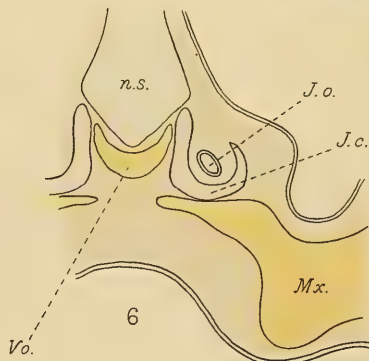
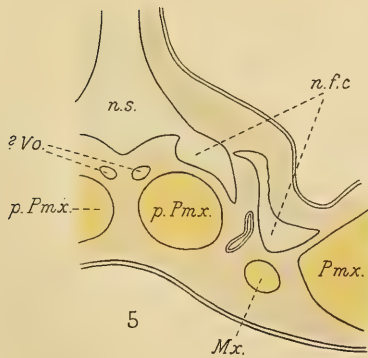
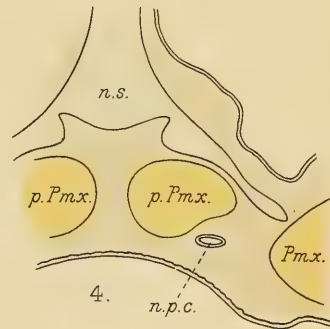
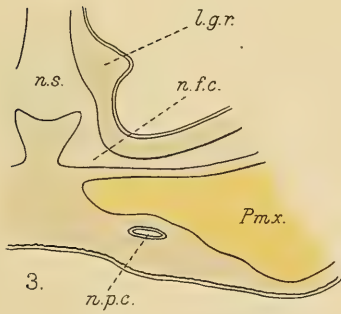
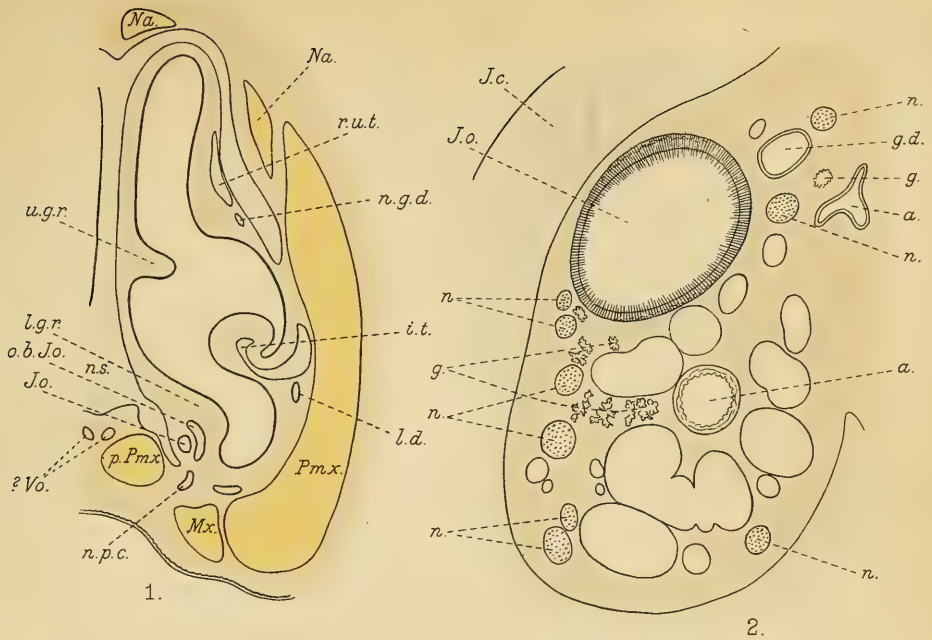
About 1898, in studying the comparative anatomy of the organ of Jacobson in Mammals, I observed that throughout whole groups the structure and relations of the organ varied very little, and that as the organ seemed to be less affected by change of habits than almost any other, it was of great importance in revealing the obscured affinities of aberrant forms. It was seen that, notwithstanding the enormous differences in most points between the Ungulates, the Carnivora, the Chiroptera, and the Insectivora, the same type of organ is found in all, while a markedly different type is found in all Rodents, and a third type in *Dasypus*. When the aberrant *Macroscelides* was examined, it was found that the organ was not at all like that of the normal Insectivores but almost typically Marsupial, showing that though for convenience the Elephant-shrew is placed with the Insectivora it has probably little real affinity with them.

Owing to the apparently isolated position occupied by *Orycteropus*, as shown by its dentition and numerous other characters, I had long been anxious to examine its organ of Jacobson, but it is only quite recently that I have had an opportunity of so doing, when, through the kindness of Dr. Péringuey, of the South African Museum, I obtained the head of a recently born specimen.

The organ and its relations have been studied by means of transverse sections, so that a comparison is easily made with the large number of other mammals in which the organ has been similarly studied.

\* For explanation of the Plate see p. 683.







Owing to the absence of well developed incisors the premaxillary bone is feeble and the palatine papilla far forward. The papilla is rather small and has no trace of a supporting cartilage. The naso-palatine, which is unusually long and passes for some distance nearly directly backwards, opens by the side of the papilla.

A transverse section through the plane of the papilla shows the nasal cavity completely surrounded by cartilage, the nasal septum below being continued into the nasal-floor cartilage and this laterally into the alinasal.

Fig. 3 on Pl. LXXI. shows a section a little behind the papilla. The nasal-floor cartilage is here seen still attached to the nasal septum but distinctly specialised. The lower glandular ridge of the septum (*l.g.r.*) is seen cut across. The premaxilla has not yet given off its palatine process. The naso-palatine canal is seen under the inner part of the premaxilla.

Fig. 4 is some distance behind fig. 3. The nasal-floor cartilage is free at its outer edge from the alinasal, and the palatine process is now seen distinct from the premaxilla.

Fig. 5 is only a short distance behind fig. 4. The naso-palatine canal is seen curving up to open into the organ of Jacobson, and the nasal-floor cartilage is dividing into an inner and outer part. The palatine process of the premaxilla is of large size. Above and to the inner side is a small ossification which may be the remains of the prevomer. It is, however, very closely connected with the anterior end of the true vomer and may have no morphological significance. The anterior end of the maxilla is seen between the premaxilla and its palatine process.

Fig. 1 is a section across the whole nasal cavity a very short distance behind the plane of fig. 5. The premaxilla is seen to be well developed. At the upper part of the section the anterior part of the nasal is shown, both parts of the bifurcated end being seen. The nasal septum is slender and the alinasal continued round the upper and outer part of the cavity. The inferior turbinal is cut across near its anterior end. On the inner side of the alinasal is a small plate of cartilage (*r.u.t.*) of doubtful significance. It is not attached to any other cartilage and would appear to be a rudimentary superior turbinal. Near the middle of the nasal septum is seen a well-developed upper glandular ridge which runs along the septum. The nasal-floor cartilage is now seen in three portions, the middle one of which is the outer bar of Jacobson's cartilage. The anterior end of the organ is seen cut across, and below it the naso-palatine canal passing on to the nasal cavity.

A little behind this plane the outer bar is seen uniting with the base of the inner part of Jacobson's cartilage and giving rise to the V-shaped section seen in fig. 6.

Fig. 6 shows the condition much behind fig. 1, and near the middle of the organ.

Fig. 2 is a more enlarged figure of the organ and its related

structures taken some little distance behind fig. 6. It will be seen that in both figures the organ is oval in section and that the ciliated epithelium is found all round, the most specialised portion being on the upper and inner sides. The greater part of the cartilaginous groove is filled by a huge venous plexus quite irregularly arranged. There is a fairly large artery, numerous nerves and a little glandular tissue. On passing further back the gland-tissue becomes much more abundant and the organ becomes reduced to a narrow duct. Jacobson's cartilage near the posterior end is reduced to a flat plate.

In the relations of the organ perhaps the most striking point is the absence of any developments of the nasal-floor cartilage to support the naso-palatine canal. Thus *Orycteropus* differs from all the Eutheria except the Edentata as exemplified by *Dasypus*, and the aberrant Insectivore *Macroscelides*. Even from the primitive Ungulates such as *Procavia* or *Sus* it differs so greatly as to suggest that any supposed Ungulate affinities must be extremely remote.

The Rodents form, so far as the organ of Jacobson is concerned, a group by themselves, but this group also must be very remote from *Orycteropus*. We are thus forced to seek for the affinities among the more primitive mammals—the Edentates, Marsupials, and Monotremes.

Besides agreeing with these early mammals in the absence of cartilaginous developments for the support of the naso-palatine canal, it further agrees with them in having preserved the outer cartilaginous bar which is probably the remains of the turbinal of the organ.

In the Edentata the organ has been described only in *Dasypus* and a few notes have been made in the case of *Manis*. *Dasypus* differs entirely from *Orycteropus* in having the organ opening into the nasal cavity and not into the naso-palatine canal and in many other details. *Manis* agrees with *Orycteropus* in having a long naso-palatine canal and in the organ opening into it, but in the absence of figures or detailed description it is impossible at present to say how far the agreement extends.

On the whole the condition in *Orycteropus* comes nearest to that in the Marsupials, but there are many points of difference, of which the most important are (1) the absence of the papillary cartilage, and (2) absence of a cartilaginous support to the lower glandular ridge. Less important are the shape of the organ, its mode of opening into the naso-palatine canal, and the very irregular venous plexus. In the structure of the nasal-floor cartilage there is some resemblance to *Echidna*, but this latter has the organ and its cartilages so much better developed that comparisons become difficult.

The evidence from the study of this region would seem to point to *Orycteropus* being descended from a line of ancestors the earlier members of which were probably allied to Marsupials, whilst the later members branched off from the Eutherian stem before any



of the higher Eutherian types had been specialised. If the *Orycteropus* line ever coincided with that of *Dasyurus* the two must very early have diverged.

My thanks are due to Dr. Péringuey for the specimen, and to Prof. Graham Kerr for the use of his laboratory while making the sections.

### References to Literature.

- R. BROOM.—“A Contribution to the Comparative Anatomy of the Mammalian Organ of Jacobson.” Tr. Roy. Soc. Edin., 1898.  
 R. BROOM.—“On the Comparative Anatomy of the Marsupial Organ of Jacobson.” Proc. Linn. Soc. N. S. W., 1897.

### EXPLANATION OF PLATE LXXI.

Fig. 1. Transverse section of snout of *Orycteropus afer*.  $\times 5$ .

Fig. 2. Transverse section of Organ of Jacobson of *Orycteropus afer*.  $\times 40$ .

Figs. 3-6. Transverse sections of lower part of snout of *Orycteropus afer*.  $\times 7$ .

*a.*, artery; *g.*, gland; *g.d.*, gland-duct; *it.*, inferior turbinal; *J.c.*, Jacobson's cartilage; *J.o.*, Jacobson's organ; *l.d.*, lachrymal duct; *l.g.r.*, lower glandular ridge; *Mr.*, maxilla; *n.*, nerve; *Na.*, nasal; *n.p.c.*, naso-palatine canal; *n.s.*, nasal septum; *o.b.J.c.*, outer bar of Jacobson's cartilage; *Pmx.*, premaxilla; *p.Pmx.*, palatine process of premaxilla; *r.u.t.*, rudimentary upper turbinal; *u.g.r.*, upper glandular ridge; *Vo.*, vomer.

2. On some Points in the Structure of the Lesser Anteater (*Tamandua tetradactyla*), with Notes on the Cerebral Arteries of *Myrmecophaga* and on the Postcaval of *Orycteropus*. By FRANK E. BEDDARD, M.A., F.R.S., F.Z.S., Prosector to the Society.

[Received May 20, 1909.]

(Text-figures 218-225.)

In April of the present year I dissected an example of this Edentate in which the blood-vessels were filled with blood, and which was so little diseased that all the viscera and their connecting ligaments were in a perfectly normal state. The excellent condition of the animal led me to take comprehensive notes concerning the principal viscera; and as there are still some lacunæ in the published accounts of the anatomy of this little Anteater, and a few organs have not, so far as I can ascertain, been examined at all, I have prepared a short account of such facts as appear to me to be new. Although the anatomy of *Tamandua* has not up to the present been exhaustively studied, we are in possession of a good deal of knowledge concerning its structure. Duvernoy\*,

\* Mém. Soc. Hist. Nat. Strasbourg, 1830, vol. i. This memoir is only descriptive of the tongue of *Tamandua* (and of the tongues of some other animals, e. g., *Echidna*, *Chamæleon*).

Chatin \*, W. A. Forbes †, Rapp ‡, and Flower § have dealt with various points in its anatomy, the first three having occupied themselves chiefly with the salivary glands, tongue, and associated structures, while Flower has given in his well-known lectures at the Royal College of Surgeons a general account of the alimentary canal in which a number of facts are mentioned for the first time. A good many anatomical details are given in the monograph of Rapp; but only the external form, the skull, and the tongue are figured by that anatomist. In fact it is the tongue and the salivary glands which have engaged the attention of most of those who have occupied themselves with the structure of this Edentate. As to the intestine, the folds which are so characteristic of this animal and *Myrmecophaga* are apparently not mentioned by Rapp. He does refer, however, to the fine network of a more minute character which is formed by the mucous membrane of the intestine. Of this he remarks that it cannot be altered by stretching the gut. I shall refer in the proper place more particularly to the memoir of Hyrtl || upon the arterial system, who figures the arteries of the brain and of the limbs. The results obtained by Hyrtl from his examination are referred to by Tandler ¶ in his important memoir upon the arteries of the brain in a series of mammals. The placenta of *Tamandua* is described by Milne-Edwards \*\*. I have myself †† referred to the alimentary canal of this Edentate, which is formed upon a simple plan like that of certain other lower mammals, the continuous mesentery of the reptiles being preserved without any of the secondary connections which are found in most other mammals. The gut had been also, and previously, described by Mitchell ‡‡. The muscular anatomy is fully described by Windle and Parsons §§, who quote previous literature. It is noteworthy that these authors, although they naturally include *Tamandua* and *Myrmecophaga* in the same family, find, nevertheless, some myological differences between them.

The brain is described by Elliot Smith |||, and some of its arteries by myself ¶¶. Upon this matter I have an additional observation to make, and am able to compare the arterial system of the brain in the genus *Tamandua* with that of *Myrmecophaga*. The specimen of *Tamandua* which I described is in the Museum of the Royal College of Surgeons. I have now some notes to offer upon a second example, which died in 1905, and of which the brain was

\* Ann. Sci. Nat. (5) xiii.

† "On some points in the Anatomy of the Great Anteater (*Myrmecophaga jubata*)," P. Z. S. 1882, p. 287.

‡ 'Die Edentaten,' Tübingen, 1852.

§ Medical Times and Gazette, 1872.

|| Denkschr. k.-k. Akad. Wien, vi. 1854.

¶ Ibid. lxvii. 1898.

\*\* Comptes Rendus Acad. Sci. Paris, lxxiii. 1871, p. 1386.

†† P. Z. S. 1908, p. 570.

‡‡ Trans. Z. S. xvii. 1905, p. 455 & p. 457, fig. 11.

§§ P. Z. S. 1899, pp. 314 & 990.

||| Cat. Phys. Series Mus. Roy. Coll. Surgeons, vol. ii. 2nd ed. (London, 1902) p. 288; and Trans. Linn. Soc. vii. 1899, p. 293.

¶¶ "On the Arteries at the Base of the Brain in certain Animals," P. Z. S. 1904, vol. i. p. 188.

injected. I am able to compare this brain with that previously described. It is interesting to notice that there are no important differences between the two brains in respect of their arterial system, which tends to inspire confidence in the fixity of this character. The rhomboidal space at the end of the medulla, formed by the division and subsequent reuniting of the basilar artery, was identical in the two specimens. In his figure of the cerebral arteries of this animal, Hyrtl\* has not represented the space referred to; so that there may be some variation. He has, however, noted—and I find that the second specimen examined by myself agrees with that figured by Hyrtl and with that figured by myself†—that the anterior communicating artery gives off a strong forwardly-running branch, which immediately loses itself between the hemispheres as the callosal artery. I shall refer to some further details in considering the corresponding arteries in *Myrmecophaga jubata*, of which I possess a well-injected brain. The cerebral arteries of this species have been described and figured by Pouchet‡. This paper is not referred to by Tandler§ or M<sup>lle</sup> de Vriese||, who have mentioned a great many other important papers upon the cerebral arterial system of the Mammalia. I find myself in general agreement with Pouchet's figure, though my specimen shows some differences from the individual studied by the French anatomist. I find that the circle of Willis is distinctly hourglass-shaped—more markedly so than in *Tamandua*. The carotids enter at the "waist" of the hourglass, as among Artiodactyles, where the circle of Willis has, as is well known, the same hourglass-shape. Anteriorly the arch of Willis is completed by the anterior communicating artery. This runs perfectly straight across the intervening space, and gives off no strong callosal artery like that of *Tamandua*. There are only some quite small branches. The Sylvian arteries (or middle cerebrals) arise from the circle of Willis asymmetrically. The right-hand artery arises exactly opposite to the anterior communicating artery; the left-hand artery (which arises by two roots, which immediately join) is behind the corresponding point on the left side. Between these arteries and the posterior cerebrals are two smaller arteries, on each side, of which the first arises just behind the exit of the carotids. The latter artery (on the left side only; there was not enough of it preserved on the right to permit of a statement) gives off immediately before it reaches the circle of Willis an artery running anteriorly, which I take to be the ophthalmic artery. The posterior cerebral arteries are rather asymmetrical, as will be seen from an inspection of text-figure 218 (p. 686). On the right side there is only one large artery, which, however, very shortly divides into two branches. On the left side three fair-sized arteries,

\* Beiträge z. vergleichenden Angiologie, v.; Denkschr. k.-k. Akad. Wien, vi. 1854, p. 21, pl. iv.

† P. Z. S. tom. cit. p. 189, text-fig. 19.

‡ 'Mém. sur le Grand Fourmilier,' Paris, 1874, pl. xiv. fig. 1.

§ Denkschr. k.-k. Akad. Wien, lxvii. 1898.

|| Arch. de Biol. xxi. 1904, p. 449.

of which, however, the anterior is considerably the larger, correspond to this. There is also here an asymmetry in the origin of the arteries, the chief artery of the left side arising anteriorly to the single posterior cerebral artery of the right side. The anterior

Text-fig. 218.

Cerebral arterial system of *Myrmecophaga jubata*.

*a.c.* Anterior communicating artery. *O.* Optic nerves. *v.* Vertebral arteries.

cerebellar arteries are also asymmetrical, thus contrasting with the arrangement met with in *Tamandua*. The right artery arises from the circle of Willis; the left arises just at the junction of the



basilar artery with the circle of Willis. The basilar artery of *Myrmecophaga jubata* is represented by Pouchet as having three spaces, where the artery divides and then shortly rejoins, instead of the single area of this kind which exists in *Tamandua* and which I have figured in the paper upon the cerebral arteries of mammals to which I have already referred. He also figures the basilar artery as remaining of considerable calibre for two or three inches down the spinal cord. The brain in my possession has not a sufficiently long piece of spinal cord attached to it to show the end of the wide region of the basilar artery. But it is nearly as long, and reaches as far as between the influx of the last two pairs of arteries figured by Pouchet. I imagine that the point where the basilar artery suddenly alters its calibre and receives two lateral arteries is really to be regarded as the junction of the basilar with the anterior spinal, and that the two lateral arteries are vertebrals. In that case the suggestion which I formerly made with regard to *Tamandua* will be wrong, and the space included along the course of the basilar artery will not be due to the anterior bifurcation of the anterior spinal artery to meet the two vertebral arteries, such as I have figured for example in *Chinchilla lanigera* \*. There will be in both these genera (*Tamandua* and *Myrmecophaga*) a basilar artery which retains either in one place only (*Tamandua*) or in more than one place a trace of being primitively a double vessel. Pouchet finds three of these double tracts of the anterior spinal †, of which he represents the first as lying immediately behind the circle of Willis. In my specimen the first of these double tracts lay just behind the Pons Varolii, and the second, which was very inconspicuous, at the extreme end of the medulla. Just in front of the first double tract arise the middle cerebellar arteries, which are symmetrical. They arise in front of the sixth nerves. The posterior cerebellar arteries, which are not symmetrical, lie between the first and second of the duplicatures of the basilar. Further back still the basilar receives two arteries on either side, which anastomose as is shown in the annexed figure (text-fig. 218, v). These are, as it appears to me, the vertebral veins, in which case this is the end of the long basilar.

### § Alimentary Canal.

The general form of the *Stomach* in this Anteater is, as known, like that of the Great Anteater, *Myrmecophaga jubata*. I may, however, mention that the entire length of the stomach, measured in a slightly oblique line owing to the form of the pyloric region, was 85 mm., of which 35 mm. belonged to the pyloric part. The breadth of the stomach—i. e., the diameter parallel with the long axis of the body—was 68 mm. The thickness of the walls of the

\* *Loc. cit.* fig. 16, p. 184.

† I hardly know where to delimit the basilar from the anterior spinal.

gizzard-like pylorus was at least 12 mm., a thickness which is quite as great as that of the other Anteater, I imagine.

The *hepato-gastric ligament* or *lesser omentum* presents one or two features of interest. The greater part of this ligament was, as in other mammals, horizontal in direction, roofing-over that section of the cœlom which communicates with the larger section of the abdominal cœlom by the foramen of Winslow. The edge of this hepato-gastric ligament, lying just over the foramen of Winslow, was raised into a deep vertical membrane fully three-quarters of an inch deep, which passes dorsally of the right central lobe of the liver. This is of course all part of the lesser omentum or hepato-gastric ligament; but the vertical part seems to me to represent the primitive ventral mesentery, connected directly with the middle line of the ventral parietes and not *via* the liver. The *greater omentum* is but little developed and, as Flower has mentioned, is not attached to the colon anywhere; it is indeed not visible when the animal is opened for dissection, being covered by rather than covering the coils of the intestines. The *splenic omentum* is short, and just laps loosely over the pancreas. It can be stretched out straight quite easily, and is inserted on to the œsophageal border of the stomach, along which runs one of the important gastric branches of the portal. It connects the pancreas and the spleen with this region of the stomach. A remarkable fact about the stomach of this Edentate is the large number of lymphatic glands which are found in the region of the stomach and, as I shall explain later, of the intestine. As to those which occur in the region of the stomach, there are first of all three, one above the other, which lie on the side of the junction between duodenum and stomach—that side which faces the abdominal cavity. These glands are in close connection with the portal branch, which passes from the œsophageal border of the stomach to join the main portal trunk as it passes dorsally to the duodenum on its way to the liver. Two other lymphatic glands lie in the lesser omentum, one near to the œsophagus and the other close to the vertical membrane already described. Finally there are two other lymphatic glands on the pancreas side of the vertical membrane—to the right, therefore, of the expanse of membrane which connects the stomach with the liver and may be termed, and is termed, lesser omentum. An eighth gland is partly imbedded in the tip of the pancreas, where it runs towards the liver in close connection with the cystic duct of the gall-bladder.

The *Small Intestine* in my specimen measured at least 97 inches in length. This is rather understating the length, I imagine, for I was anxious not to stretch it unduly. Sir W. Flower gives 100 inches as the length of the small intestine in the example measured by himself. In the latter example of *Tamandua* the colon was only  $5\frac{1}{2}$  inches long; I found that from the cæcum to the anus was quite 7 inches in my specimen. Sir W. Flower remarks that the duodenum has no mesentery attaching it to the

dorsal middle line; and I also have failed to find this duodenocaval ligament, as I suppose that mentioned by Flower to be.

Flower has called attention to the fact that this Anteater, like *Myrmecophaga*, possesses a ventral longitudinal fold in the jejunum and ileum, which is a fixed fold and cannot be obliterated by stretching the walls of the gut. I have examined this structure carefully in *Tamandua*, and am able to give a rather more detailed account of it than was given by Flower. In the duodenum there is some longitudinal corrugation of the walls of the gut. But the continuous ventral "typhlosole" does not commence until about 35 inches behind the stomach. In front of this the fold is occasionally seen to the extent of about an inch. The fold is not absolutely continuous from its commencement 35 inches below the stomach. There are two slight gaps at first, two or three fourths of an inch wide. Thereafter this typhlosole is quite continuous as a conspicuous raised fold for a distance of 28 inches. There are in this tract occasional and short branches of the fold, and also short subsidiary and parallel folds. The main fold is fairly deep and very conspicuous. Then follows a gap of 7 inches, where the internal surface of the intestine is smooth. After this there is a tract of 20 inches where the typhlosole is again visible; but it is here, except indeed for very short distances, not nearly so well-marked as it is anteriorly, and there are more subsidiary folds and anastomosing branches. The different appearance will be readily gathered from an inspection of text-fig. 219 (p. 690), which represents pieces from different regions of the small intestine. The rest of the ileum, 7 inches in length, has not any ventral typhlosole. It is clear from the descriptions of both Owen\* and Forbes† that the arrangement of this typhlosole in *Tamandua* differs in detail from that of *Myrmecophaga*. For both of these anatomists write of a continuous fold throughout the ileum which, according to Forbes, occupies 15 feet 3 inches out of a total intestinal length (of the small intestine) of 24 feet 10 inches. In front of this are at intervals detached tracts of this typhlosole-like fold. In *Tamandua*, on the other hand, the fold is best developed and continuously so in the middle region of the small intestine.

In writing of the intestinal coil of Mammals‡ it had escaped my attention that Sir Richard Owen had already referred to the "Reptilian" character of the gut of *Myrmecophaga*, though I duly noted that Sir W. Flower had described the condition of the gut in that Edentate. It is possible that Flower's statement was taken from Owen's paper, to which he referred. Owen wrote of *Myrmecophaga*§ that "one common duplicature of peritoneum, continued from the middle of the back part of the abdomen, and 18 inches in extent where it is broadest, at the junction of the ileum with the colon, supports the whole intestinal canal, as in

\* Trans. Z. S. vol. iv. p. 122.

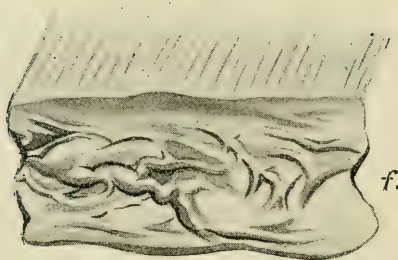
† P. Z. S. 1908, p. 570 footnote.

‡ P. Z. S. 1882, p. 290.

§ Trans. Z. S. iv. p. 121.

most reptiles—mesentery, mesocolon, and mesorectum being one and the same fold.” I can confirm my former statement that *Tamandua* agrees in this particular, a confirmation being important in view of the fact that this condition of the gut appears

Text-fig. 219.

*b.d.*Three pieces of small intestine of *Tamandua tetradactyla*.

The upper figure is a portion of the duodenum showing papilla of bile-duct (*b.d.*) and absence of “typhlosolar” fold. The two remaining figures are from the jejunum, and the “typhlosolar” (*f*) is present.

to vary in *Centetes*. I take this opportunity of adding that in an example of *Myrmecophaga jubata* dissected subsequently to the date of my paper quoted below, there was no ligamentum]cavo-



duodenale. The gut was in fact quite "Reptilian." Owen has remarked\* upon a huge mesenteric gland 16 inches long which lies parallel with the puckered coils of the small intestine, on the rectal side of which, and therefore parallel to it, lies a row of detached glands. I find a quite similar series of glands in *Tamandua tetradactyla*. There is one gland more or less crescentic in shape which extends from close to the pancreas anteriorly to near the commencement of the colon posteriorly. Besides this there is a chain of detached glands seven or eight in number which lie to the colic side of the large gland and are also disposed in a crescentic form, thus following the curves of the large gland. All these lymphatic glands are dark in colour, as Owen states them to be in *Myrmecophaga jubata*. The number of the smaller glands is not stated in *Myrmecophaga*. The detailed agreement between the two Anteaters is, however, remarkable, even if the exact number of the smaller glands does not tally in the two cases.

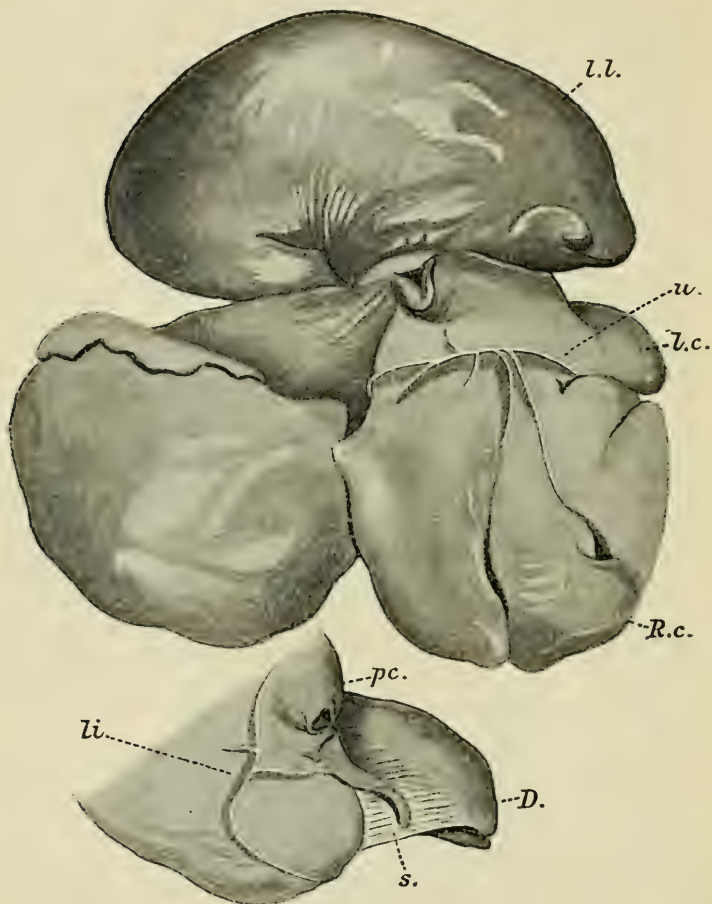
The *Liver* is, as Sir W. Flower has pointed out, like that of *Myrmecophaga* in the disposition of the lobes. I may mention that when this viscus is viewed from the diaphragmatic aspect it is seen to consist of three definite lobes only; for the right and left central are not so definitely distinguishable from each other on this view as are either the left lateral or the right lateral from the conjoined centrals. The falciform ligament shows a peculiarity which I have not observed elsewhere. It divides (see text-fig. 220, p. 692) of course the right and left central lobes, marking the central fissure of the liver. It gives off three seams which traverse the surface of the liver, of which two, those on the right side, run to the clefts separating the right central into three subdivisions, one of which is the cleft in which lies the gall-bladder. The third seam arises in front of these, and passes to the left just above the end of the cleft which separates the left central from the left lateral lobe. On the under (abdominal) surface of the liver there is a series of membranous seams visibly connected with ligaments in the same way.

The edge of the right lateral lobe of the liver is fixed down to the diaphragm, just in front of the suprarenal body, by a sheet of membrane which towards the median side slightly covers the suprarenal body, and is attached to the postcaval vein. This part of the ligament is of course the equivalent of the hepatocaval membrane of other mammals. This membrane is continuous with a semicircular seam which, as it were, cuts off a semicircular piece from the lower part of the right lateral lobe of the liver. On the median side (*i.e.*, the left side) this seam gives off a branch which runs forward and to the left, and branches once or twice on the caudate lobe. The latter lobe splits into two at its connection with the entering postcaval vein, and it is here closely adherent to that vein. It should be mentioned also that the

\* *Loc. cit.* p. 121.

gall-bladder is just visible on the diaphragmatic surface of the liver. The ductus choledochus, which receives the pancreatic duct just before its entry into the duodenum, is not specially dilated, as I have found it to be in *Myrmecophaga*, before its

Text-fig. 220.

Liver of *Tamandua*.

The upper figure represents the diaphragmatic surface of the organ.

u. Umbilical ligament with its branches. l.c. Left central lobe of liver. l.l. Left lateral. r.c. Right central.

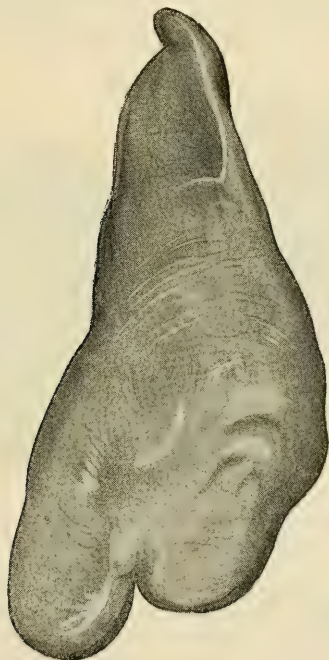
The lower figure represents a portion of the right lateral lobe showing the seams (li.) described in the text.

D. Diaphragm. pc. Postcaval vein where it enters liver. s. Ligament running from liver to diaphragm, which bears, as is shown in the figure, the suprarenal body.

termination on the extremity of a long low fold of the duodenal mucous membrane which has a recess (text-fig. 219, *b.d.*, p. 690) round the opposite extremity. It is about 2 inches from the pylorus.

The *Spleen* is rather different in form from that of *Myrmecophaga*, and is represented in the accompanying figure (text-fig. 221), which will serve in lieu of an elaborate description. It is nearly of the form of an isosceles triangle with a base line of 84 mm.; the two sides measure respectively 54 mm. and 67 mm.; the shorter side lying to the left of the body has two rounded lobate projections.

Text-fig. 221.



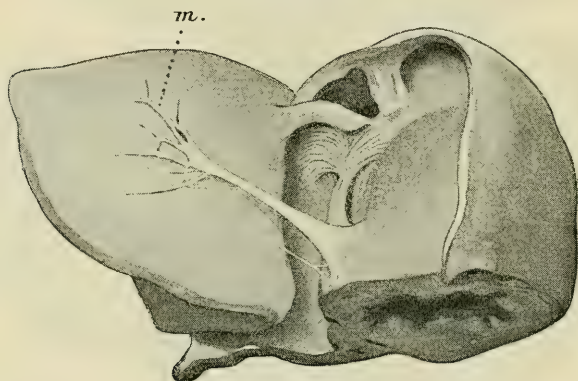
The spleen of *Tamandua tetradactyla*.

The *Pancreas* from the duodenum to the spleen is 4 inches in length; on the other side of the duodenum it extends a long way towards the liver. A lieno-caval ligament arises from the edge of the spleen and is attached along the posterior border of the pancreas for about half of the length of the latter; it is not inserted anywhere upon the left kidney. Arching over and nearly concealing the left suprarenal body, it is inserted upon the postcaval vein of its side, and can be traced down that vein and along the spermatic vein right down to the left testis, on which it ends.

§ *Heart and Vascular System.*

The cavity of the right ventricle of *Tamandua* showed two interesting features which deserve comment. There is, in the first place, a very strongly developed moderator band which is represented in the annexed text-figure (text-fig. 222). This consists of a somewhat slender muscular band which arises just below the great septal papillary muscle of the auriculo-ventricular valve. The muscular band from the septal wall of the ventricle enters this moderator band from above. On the posterior side it seems mainly formed as a process of the endocardial lining. Near to the free wall of the ventricle it separates into many tendinous branches shown in the figure, which would take too long a space to describe individually. These spread out in their abundant ramifications and anastomoses over a considerable area

Text-fig. 222.



A portion of the heart of *Tamandua*, with the right ventricle opened to display the moderator band (*m.*).

of the free wall of the ventricle. A single tendinous thread arising near to but independently of the moderator band also connects the septal with the free wall of the ventricle. Moderator bands are not uncommon\* in the right ventricle, and are known in birds as well as mammals. It appears that a similarly situated moderator band occurs in the Great Anteater also. For in a figure of the interior of the right ventricle of that animal, Sir E. Ray Lankester has represented† a muscle cut off short which arises from the septal wall of the ventricle close to and behind the chief muscle of the auriculo-ventricular valve. He has not, however, given any description of this structure, with which indeed he was not concerned in the paper quoted. The right

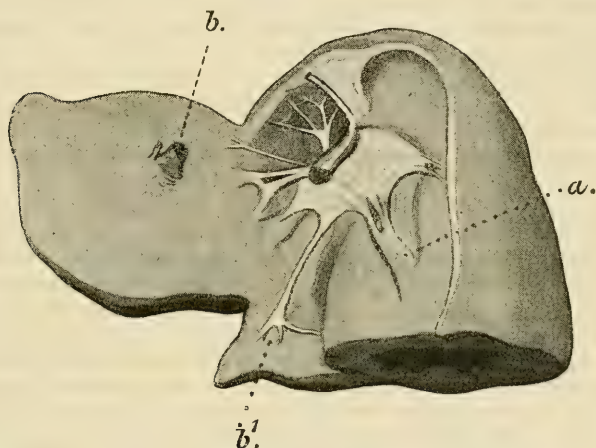
\* Cf. *e. g.* Bindo de Vecchi, *Anat. Anz.* xx, 1902, p. 374, where some literature is cited.

† P. Z. S. 1882, pl. xli. fig. 20.



auriculo-ventricular valve, which is incompletely shown in the same text-figure (text-fig. 222), has a very complicated series of papillary muscles, as is better shown in text-fig. 223. As in the Great Anteater\*, the tricuspid valve is attached at the extreme left directly to the septal wall of the ventricle; there is here no development of a papillary muscle or muscles. The great or anterior papillary muscle ("a" in Sir E. Ray Lankester's figures) is partly divided into two, but not so markedly as he figures it in the genus *Myrmecophaga*. From the collar of the valve exactly opposite to the anterior papillary muscle arise two muscles which appear to be represented but are not lettered in the drawing of Lankester already referred to. These are fixed to the free wall of the ventricle. The right-hand one of them, which is the

Text-fig. 223.



The same heart with the moderator band removed to show more plainly the structure of the right auriculo-ventricular valve.

- a. The left (great) anterior papillary muscle. b¹. The right (lesser) papillary muscle. b. Muscle arising from the free wall of the ventricle and attached (the other cut end is also shown) to the actual collar of the annular valve.

smaller, is nevertheless the more conspicuous, since it is attached farther towards the apex of the heart upon the free wall of the ventricle. The arrangement of these muscles is very suggestive of the muscles lettered "m" and "n" in Lankester's figure of the heart of *Ornithorhynchus*.

The right anterior papillary muscle in *Tamandua* is a very slender muscle attached to the free wall of the ventricle. To this series may be also referred a double muscle situated more to the right, and also arising from the free wall of this ventricle.

\* Cf. Lankester, *loc. cit.* fig. cit. "e."

Finally, the anterior cusp or cusps of the tricuspid valve are also attached by chordæ tendineæ to the right-hand of the two papillary muscles, which are connected with the septal cusps of the valve. It is to be noted that these muscles also spring from the free wall of the ventricle. They correspond, I take it, with those lettered "c" in Lankester's figure of the human heart. My illustration also shows the remainder of the papillary muscles of the septal flap of the valve, of which still another is attached mainly to the free wall of the ventricle. It appears to me that the chief features of interest in the structure of the right auriculo-ventricular valve of *Tamandua* are, in the first place, the very great amount of its attachment by papillary muscles to the free wall of the ventricle, in which it contrasts very markedly with such a type as *Lepus*\*; and, in the second place, the insertion of papillary muscles which are fleshy throughout upon the actual collar of the annular valve—a state of affairs which is closely paralleled in *Ornithorhynchus*, but is at least not always found among the Eutherian Mammals.

The *Aorta* has, at any rate, no perforate or partly perforate ductus Botalli between itself and the pulmonary artery, where they cross. I could, indeed, see no definite separate ligament representing this former arterial connection in the specimen which I dissected. On cutting open the thoracic aorta the orifices of the intercostal arteries could be counted. I examined nearly the whole of this region of the aorta; but, through an oversight, omitted to ascertain exactly the topographical limits of the section of artery which I cut open. It had been already removed from the body. In this section of aorta the first five intercostal orifices were single apertures into the aorta, though they divided at once only just below the orifice into the aorta. The sixth orifices were paired. But the two intercostal arteries opened into the aorta, one a little nearer to the heart than the other. I have already called attention to a similar asymmetry in the case of *Chiromys madagascariensis*†, where one of several pairs of intercostals opened into the aorta a little in advance of its fellow. After this pair of intercostals I counted seven single orifices into the aorta. This animal, therefore, contrasts with *Chiromys* and some other mammals, to which I have referred in the memoir quoted below, in the prevalently unpaired character of the intercostal arteries. The intercostal arteries, moreover, have a relationship to the azygos vein which varies in different mammals. It differs, for example, in *Tamandua* very much from the conditions which I have described in *Chiromys* already referred to. In *Tamandua* the right azygos vein, as in other Edentates, is the only azygos, and it extends through the whole of the thoracic cavity, down to nearly the diaphragm. It is a large vein, and gives off its branches, on the right side at least,

\* Lankester, *loc. cit.* pl. xxxviii. figs. 3, 4.

† "Some Notes upon the Anatomy of *Chiromys*, &c.," P. Z. S. 1908, pp. 698 & 699, text-fig. 152.

with perfect regularity, a branch on the posterior side of each rib. There are eleven such branches behind the point where the azygos in front opens into the anterior caval to form the ductus Cuvieri. To each of these also of course corresponds an intercostal artery. Throughout the whole of its course the intercostal arteries underlie the azygos when viewed in the ordinary position of dissection. That is to say, they are dorsal to it. The azygos ends, after the last branch already mentioned, without any diminution of calibre by plunging into the thickness of the body-wall. It is only after this point that the intercostal arteries are visible throughout their whole extent from their origin from the aorta to their entering the body-wall. This state of affairs contrasts with that of, at any rate, a large number of mammals including, as already mentioned, *Chiromys*. In all mammals which I have hitherto examined as to this point, the first set of intercostals, varying in number in different mammals, underlie the azygos, and then at a fixed point, varying for the species or genus, they cross over the vein overlying it in the position in which they are seen on dissection. So that the intercostal arteries can be divided into two series, of which one set are dorsal and the other ventral to the azygos. This difference in the conditions found among mammals has no relation, as it would appear, to the length of the azygos. They sometimes cross the azygos some way from its end in cases where the vein extends quite as far back towards the diaphragm as it does in *Tamandua tetradactyla*. Posteriorly the aorta divides into two branches, each of which at once divides again to form external and internal iliacs. The caudal artery arises from the right-hand inner iliac.

*Postcaval veins and their branches.*—In a recent paper upon the postcaval-vein in Mammals I have, I believe, quoted the authorities for the principal facts known about the main venous trunks of the Edentata. I need not, therefore, recapitulate the literature here. It is not, however, certainly known whether *Tamandua* agrees with other Edentates in the double postrenal section of the postcaval. It might well be inferred, however, that this was the case on account of its close resemblance in other characters to *Myrmecophaga*. As a matter of fact *Tamandua tetradactyla* has double postrenal postcavals, which I am now able to describe together with their principal branches. The postcaval vein is double from quite the beginning of the kidney region, as is also the case with *Myrmecophaga*. The renal veins, which are single, are given off from the divided part of the postcaval, in both of which particulars this Edentate differs from some others, for example from *Tatusia peba* \*. The divided postcaval, after the origin of the renals, closely embraces the aorta which just fills up the gap.

The *spermatic veins*, as in other Edentates, arise from the

\* Beddard, "On the Postcaval Vein," P. Z. S. 1909, p. 509, text-fig. 135.

renals on each side. They run straight to each testis, and the vessels appear to form a rete in the suspensory membrane of the testis in which they lie. This formation of a rete is seen in other cases among the Edentata—for example in various Armadillos, where it has been figured by Hochstetter and by myself. There is, however, in this no essential difference from what is seen in other mammals; for generally the spermatic veins in the neighbourhood of the testes or ovaries form a rete. It is only more conspicuous, and commences further away from the testes, in the Edentata now under consideration. The veins which pass between the testes and the postcaval vein seem to me to be limited to the equivalents of the anterior spermatic veins of other mammals. I could find no trace in *Tamandua* of a posterior spermatic vein joining the anterior on each side and flowing into the postcaval in the lumbar region, such as does occur in some Armadillos and in most Marsupials in addition to the anterior pair. I feel quite convinced that this is really the case in *Tamandua*, for after searching for the vein I carefully cut the suspensory ligament of each testis and observed no bleeding or the slightest trace of the smallest vessel in this ligament other than those already referred to. It will be remembered that the Armadillos vary from species to species in the presence or absence of a posterior spermatic vein.

There are no *lumbar parietal veins* given off until some way after the two postcavals have diverged greatly from each other towards the thighs in the pelvic region. Here two such veins are given off, at any rate on the right side where I studied them most carefully. The two veins anastomose just before entering the postcaval. Owing to the position of the vein where they arise, the lumbar parietals run anteriorly parallel with the long axis of the body. Each vein lies one on each side of a corresponding artery. On the opposite side of the postcaval is a corresponding pair of small veins which run in exactly the opposite direction, *i. e.* towards the pubic symphysis. Here again the two veins lie one on each side of a corresponding artery. The position of the lumbar parietal veins is quite suggestive of the lateral abdominal vein in Lizards.

The double character of these lumbar veins is to be noted, since in other mammals, for instance among the Carnivora\*, these veins are frequently double from the very first, or begin to be so at a very short distance away from their orifice into the postcaval vein or veins.

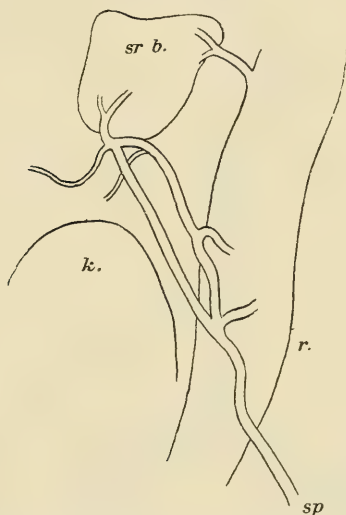
Although there is no direct affluent into the postcaval below the orifice of the renal veins of a spermatic vein on either side comparable to the posterior spermatic vein of other mammals, *Tamandua* possesses on each side of the body a peculiar longitudinal vein, which I have studied more exactly on the right side of the body; I have, however, ascertained that the vein

\* Beddard, "Anatomy of *Galidia*, &c.," P. Z. S. 1909, p. 486, text-figs. 129 & 130.



exists on the left side and has substantially the same origin and course, though I can give no details so minute as I am able to give of the right-hand vein. The right suprarenal body emits a short vein which runs rather backwards and opens into the undivided section of the postcaval. The lower part of the suprarenal body behind that part which is connected with the suprarenal vein proper gives off some twigs which are connected with two or three slender veins supplying the parietes in front of the kidney. These various veins collect into a stronger vein with which their exact connections are shown in the accompanying figure (text-fig. 224). This vein is twice connected with the

Text-fig. 224.

Diagram of persistent right postcardinal (?) of *Tamandua*.

*r.* Right renal vein. *k.* Outline of kidney. *sr.b.* Suprarenal body. *sp.* Spermatic vein, which represents persistent cardinal and opens into renal vein &c.

postcaval by short branches and it runs close to the postcaval vein and ventrally to it, *i. e.* on top of it as seen in dissecting the animal. The vein crosses over the renal and passes into the mesorchium, joining the spermatic plexus in a way which I have not exactly ascertained. Here then is a vein which lies on the whole to the outside of the postcaval and which conveys blood from the testis, not only directly to the postcaval, but also to the suprarenal body and to the parietes in its immediate neighbourhood. There are at present no embryological data as to the veins of the Edentata. But it is to be assumed in the meantime that like other Mammals the postrenal sections of the postcavals

are to be referred to the subcardinals. And also that the postcardinals partly persist as a portion of the spermaties. If this be so, then the vein which I have just described will be referable to a more largely persisting postcardinal on each side. The orifices into the postcaval will be the remains of the frequent junctions between the postcardinal and the subcardinal. Innumerable such junctions, for instance, are figured by McClure in the embryo *Dasyure*\*. Moreover, a vein connecting in its course the gonad and the suprarenal bodies and the parietes is suggestive of the suprarenal parietals of the lower Vertebrata, which are perhaps to be looked upon, as I have suggested, as remnants of the postcardinals in that region. It will be noted, of course, that this longitudinally running vein cannot possibly be regarded as the missing posterior spermatic; for it opens into the postcardinals on each side in a region too anterior to permit of a comparison with that vein in other Mammals.

I did not find any caudal plexus of veins such as is to be met with in many but not in all (?) *Dasypodidæ*.

The *portal vein* on reaching the pancreas received a strong gastro-splenic branch consisting of a short vessel from the stomach and a long vein running along the whole length of the pancreas to the spleen. The main gastric branch entered nearer to its entry into the liver.

*On the Postcaval Vein and its branches in Orycteropus capensis.*

In completing an account of the double postcaval vein and its branches in Armadillos and in *Manis gigantea*, Dr. Hochstetter† observed that “Das Vorkommen einer doppelten hinteren Hohlvene scheint demnach bei den Gürtel- und Schuppenthieren die Regel zu sein, und es wäre nicht uninteressant, zu erfahren, wie sich in dieser Richtung die anderen Edentaten verhalten.” This expectation was realised by the same writer, who later‡ described these veins in the Bradypodidæ. I have myself§ dealt with a few Armadillos which were not known to Hochstetter, and in the present communication to the Society with the double postcaval vein of *Tamandua*||.

I am now able to add an appendix descriptive of the postcaval vein and its branches in *Orycteropus*, which have not, as I believe, been described, unless my predecessors in this department of anatomy have overlooked some earlier account. Even in that case a redescription of veins, which are known to vary at times from individual to individual, will not be without its use.

The specimen of *Orycteropus capensis* which I dissected was a male which died on May 31st last; it was not an old individual for the testes were completely abdominal¶, lying not very far

\* Am. Journ. Nat. 1906, vol. v. p. 176, fig. 9.

† Morph. Jahrb. Bd. xx. 1893, p. 622.

‡ Morph. Jahrb. Bd. xxv. 1898, p. 362.

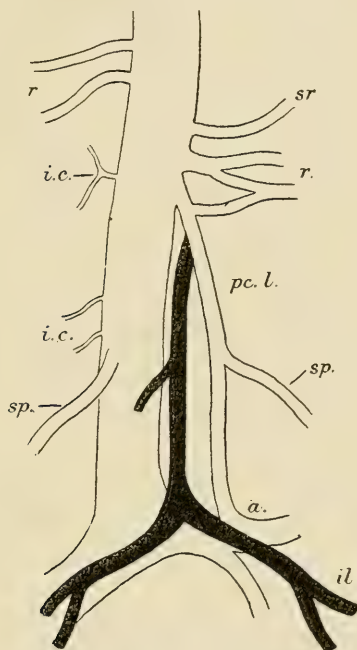
§ P. Z. S. 1909, p. 505.

|| *Suprà*, p. 699.

¶ See Flower, “On the Edentates,” P. Z. S. 1882, p. 364.

behind the kidneys, whereas in the adult they are at least inguinal and even descend it is alleged into a scrotum during the breeding season. The animal measured about 4 feet 6 inches and was, therefore, obviously not full grown. On the other hand, it was as clearly in no way "newborn," and thus the long retention of the testes within the abdomen must be a character of the animal and not a mark of juvenility.

Text-fig. 225.

Postcaval veins of *Orycteropus*.

*a.* Point of junction of left postcaval and left iliac vein. *i.c.* Intercostal veins.  
*il.* Iliac artery. *pc. l.* Left (smaller) postcaval. *r.* Renal veins. *sr.* Supra-renal veins. *sp.* Spermatic veins.

The veins were quite full of blood and in consequence easy to follow. I am able therefore to give, with some confidence, the following results of my examination of this specimen of *Orycteropus capensis*. The postcaval vein at first sight appeared to be single. For in the middle line (text-fig. 225), or nearly so, to the right of the aorta, lay a large turgid vein of the full calibre that such a vein would be expected to possess in an animal of this size. A closer examination, however, soon showed that on the opposite side of the aorta, *i. e.* on the left side, lay another vessel, parallel

to the first mentioned and not more than one third of its calibre, which was also distended with blood. I believe that so marked a difference in size between the two postcaval veins, when there are two, is not an even exceptional occurrence among Mammals. It recalls the unequal postcavals in the Lacertilian genus *Tiliqua*. In Lizards the two postcavals are apt to be equal, but among the Skinks are at least sometimes unequal in calibre. There is no question, it will be noted, in *Orycteropus* of a minute disagreement in size between the two postcavals. The difference is so great that the left-hand vein was in the first place altogether overlooked and regarded as being merely the proximal end of the spermatic vein of that side of the body. It is thus important to recognise a well-marked difference between *Orycteropus* and other Edentates at the very first. Still there remains the more important fact of the double nature of the postrenal section of the postcaval. The less important part played by the left-hand division in the venous system of this Edentate as compared with other Edentata is also shown by the posterior ending of the left postcaval and by the origin of the intercostal veins. As to the former point, it is to be noted that the large right-hand postcaval, arrived at the posterior end of the abdominal cavity, divides, as usual in animals with but a single postcaval vein, into the two iliacs. These in the usual way underlie the aorta and its posterior bifurcation, as is shown in the accompanying illustration (text-fig. 225, p. 701). When the left-hand postcava is followed backwards it is seen to open into the left iliac vein. Of this vein it is clearly a rather unimportant affluent, for the main trunk reaches the right postcava.

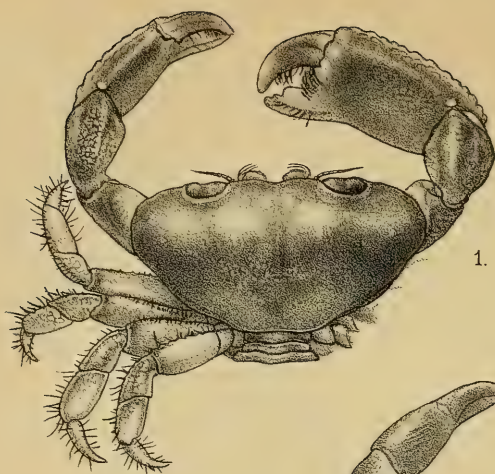
The arrangement of the two postcavæ is thus different from that of other Edentates, where the independence of the two trunks is emphasized by the fact that each is concerned with the iliac vein of its own side, or if there be a communication between them it is of such a kind as not to interfere with the equal importance of the two veins, such as, for example, the two communications which I have figured in the Insectivore *Centetes ecaudatus* \*. The remaining point of difference between the two postcaval veins concerns, as has been stated, the intercostal veins. Of these there are three lying between the point of bifurcation of the veins and the right-hand spermatic vein. The intercostal veins, however, have nothing whatever to do with the left postcaval trunk. They all open into the large right postcaval and rather to the left of the vessel so that their position is very nearly, if not actually, median. They were of small size although they were full of blood, and the first of the three divided immediately after, or rather before, its entrance into the right postcaval into two branches, an anterior and a posterior. The veins, in fact, are not paired as right and left trunks.

There is thus in *Orycteropus* an approach to the more usual

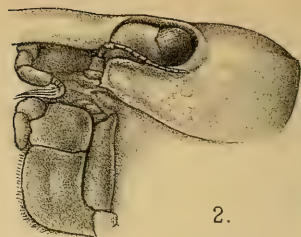
\* P. Z. S. 1909, p. 511, text-fig. 136, A.



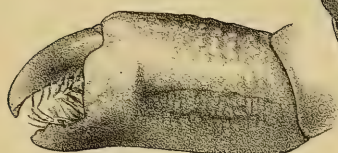




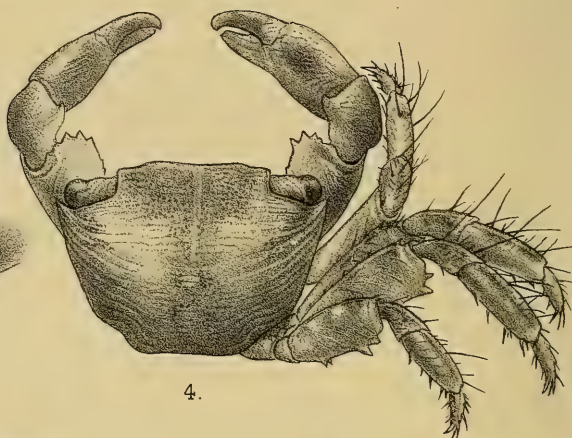
1.



2.



3.



4.



5.



7.



9.



6.



8.

G.M.Woodward del. et lith.

West, Newman imp.

1-3, LIOXANTHODES ALCOCKI. 4, 5, SESARMA MURRAYI.  
6, 7, HYASTENUS ANDREWSI. 8, 9, H. UNCIFER.

Eutherian condition of the postcaval vein. Furthermore the two veins may be compared with the *Didelphys* embryo figured by McClure\*, where the right cardinal collateral is immensely larger than the left-hand vein. This is one among many variations which occur in the venous system of the embryos, as well as the adults, of that marsupial. Both this variation in *Didelphys* and the adult condition in *Orycteropus* appear to me to be an intermediate step in the reduction of the two veins found in Monotremes and Edentates to the single right-hand postrenal postcaval of other Eutheria.

I now turn to the branches of the postcaval vein. The renals are as is usual asymmetrical, the right-hand veins flowing into the postcaval a little anteriorly to those of the left side. There are two renal veins on each side, and those of the left are connected by an obliquely running joining vessel. Of these two latter vessels the anterior arises from the postcaval vein, where it is single, and the posterior from the slender left postcaval. It is very important to notice, from the point of view of a comparison with other Edentates, that the renals are quite unconnected with the spermatic veins. No recognisable branch appeared accompanying the ureter. The spermatic veins themselves, as is shown in text-figure 225, are quite symmetrical with each other and arise each from its own postcaval vein about half-way down between the renal and the posterior bifurcation of the postcaval.

There is no caudal plexus and the veins are not so massive as in various Armadillos; nor is there any tendency to form plexuses, such as are often met with in the Armadillos. In fact the venous system of *Orycteropus* is in its entirety more approaching that of other Eutherian Mammals.

3. On Decapod Crustacea from Christmas Island, collected by Dr. C. W. Andrews, F.R.S., F.Z.S. By W. T. CALMAN, D.Sc., F.Z.S.†

[Received May 22, 1909.]

(Plate LXXII.‡)

I. *Introductory.*

This paper deals with the Decapoda collected by Dr. Andrews on his second visit to Christmas Island in 1908. The names of a few specimens obtained during his stay on the island in 1897-98 but not hitherto determined are also included in the list given below.

Dr. Andrews has pointed out (P. Z. S. 1900, p. 116) that "the shores of Christmas Island are singularly unfavourable for the collection of marine animals," and practically all the marine

\* Am. Journ. Anat. vol. v. no. 2, 1906, p. 193, fig. 15.

† Published by permission of the Trustees of the British Museum.

‡ For explanation of the Plate see p. 713.

species here recorded were obtained in one place, at Flying-fish Cove. In addition to collections made on the reef a rich fauna was found sheltering in crevices of the wooden piles of the pier, and many of the smaller Decapoda, as well as Isopoda, Amphipoda, and Pycnogonida, were got in this way.

It would be of much interest to determine whether the littoral fauna of Christmas Island shows any peculiarities correlated with its very isolated geographical position. The present collection, at all events, gives no clear evidence of any such peculiarities; the larger Decapods, without exception, belong to well-known and widely-ranging Indo-Pacific species, while the few new species which I have to describe belong to the groups of the smaller and less conspicuous forms among which novelties may be expected anywhere. On the other hand, the restricted opportunities for collecting forbid us to attach any importance to the absence of many widely-distributed species from the collection. It must be borne in mind also that our knowledge of the Indo-Pacific littoral Decapods is still far from adequate for discussion of zoogeographical problems.

The terrestrial and fresh-water species in the following list are distinguished by an asterisk. All of these have been already recorded from the island (although sometimes under different names) except the two species of *Geograpsus* which, Dr. Andrews tells me, are abundant on the shore terrace at Flying-fish Cove. *Ptychognathus pusillus* was found only in the pool above the waterfall on the east coast, where it was collected by Dr. Hanitsch\*, but *Palemon lar* (apparently identical with the variety described by Dr. de Man, *l. c.*) was found not only in that locality but also in Hugh's Dale and Sidney's Dale on the west coast.

A few minute crabs and a larger number of small Caridea remain over which I cannot identify with any described species but which, from the imperfection of the specimens or for other reasons, I do not attempt to describe as new. The Alpheidæ, of which a number were collected on the reef, are omitted altogether for the present.

## II. List of the Species.

### XANTHIDÆ.

- Carpilodes rugatus* (Latr.).
- „ *vaillantianus* A. M.-E.
- „ *cariosus* Alc.
- Lioxanthodes alcocki*, g. et sp. n.
- Zozymus ieneus* (Linn.).
- Lophozozymus dodone* (Herbst).
- Xantho bidentatus* A. M.-E.
- Leptodius sanguineus* M.-E.
- „ *cavipes* (Dana).

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\* See de Man, P. Z. S. 1905, p. 537.



## XANTHIDÆ (continued).

- Actæa tomentosa* M.-E.  
 „ *rufopunctata* M.-E.  
 „ *speciosa* (Dana).  
*Daira perlata* (Herbst).  
*Xanthodes lamareckii* (M.-E.).  
 „ *notatus* Dana.  
*Chlorodius niger* (Forsk.).  
 „ *lævissimus* Dana.  
*Phymodius sculptus* (A. M.-E.).  
*Chlorodopsis areolata* (M.-E.).  
 „ *venusta* Rathbun (?).  
*Cyclodius gracilis* Dana.  
*Cymo melanodactylus* de Haan.  
*Eriphia lævimana* Latr.  
 „ *scabricula* Dana.  
*Trapezia cymodoce* (Herbst).  
 „ *ferruginea* Latr.  
 „ *ferruginea*, var. *areolata* Dana.  
 „ *digitalis* Latr.  
 „ *rufopunctata* (Herbst).  
*Tetralia glaberrima* (Herbst).  
*Domecia hispida* Eydoux & Souleyet.  
*Melia tessellata* Latr.

## PORTUNIDÆ.

- Thalamita* sp. (juv.).

## OCYPODIDÆ.

- Ocypoda ceratophthalma* (Pallas).

## GRAPSIDÆ.

- Grapsus grapsus* (Linn.).  
 „ *strigosus* (Herbst).  
 \* *Geograpsus grayi* (M.-E.).  
 \* „ *crinipes* (Dana).  
 \* *Ptychognathus pusillus* Heller.  
*Sesarma murrayi*, sp. n.  
*Liolophus planissimus* (Herbst).

## GECARCINIDÆ.

- \* *Cardisoma hirtipes* Dana.  
 \* *Gecarcoidea lalandii* M.-E.

## MAIIDÆ.

- Achæus spinosus* Miers (?).  
*Oncinopus aranea* de Haan.  
*Camposcia retusa* Latr.  
*Hyastenus andrewsi*, sp. n.  
 „ *uncifer*, sp. n.  
*Tylocarcinus gracilis* Miers.  
*Perinea tumida* Dana.  
*Schizophrys aspera* (M.-E.).

## DYNOMENIDÆ.

*Dynomene* sp.

## PORCELLANIDÆ.

*Petrolisthes dentatus* (M.-E.).,, *coccineus* (Owen) (?).*Pachycheles sculptus* (A. M.-E.).

## GALATHEIDÆ.

*Galathea affinis* Ortmann (?).

## PAGURIDÆ.

*Calcinus herbstii* de Man.

## CÆNOBITIDÆ.

\* *Cænobita rugosus* M.-E.\* ,, *clypeatus* Latr.\* *Birgus latro* (Linn.).

## PALINURIDÆ.

*Panulirus penicillatus* (Olivier).,, *versicolor* (Latr.).†,, *longipes* (M.-E.) (? juv.).

## STENOPIDÆ.

*Stenopus hispidus* (Olivier).

## HIPPOLYTIDÆ.

*Lysmata seticaudata* (Risso).

## PANDALIDÆ.

*Thalassocaris lucida* (Dana).

## PALÆMONIDÆ.

\* *Palæmon lar* Fabr., var.*Coralliocaris graminea* (Dana).,, *superba* (Dana) (?).III. *Systematic Notes and Descriptions of New Species.*

## Family XANTHIDÆ.

## LIOXANTHODES, gen. nov.

Carapace extremely broad, strongly convex antero-posteriorly, smooth; antero-lateral borders thick, with only traces of division into three lobes; postero-lateral borders very strongly convergent, straight.

Front one-third of width of carapace, strongly deflexed, slightly notched. Orbits large, without suture-lines. Fronto-orbital border about two-thirds of width of carapace.

Antennules folded transversely. Basal antennal segment short

† I have described elsewhere some young stages of this species obtained by Dr. Andrews (Ann. Mag. Nat. Hist. (8) iii, p. 441, 1909).

and broad, not reaching front; the short flagellum standing in orbital hiatus.

Endostomial ridges very slightly developed, not reaching to anterior margin of buccal frame.

Chelipeds massive, unequal in both sexes; fingers not hollowed at tip.

Abdomen of male with third to fifth somites coalesced.

Type species, *L. alcocki*, sp. n.

The little crab described below presents a combination of characters which seems to exclude it from any of the existing genera of Xanthidæ. The great width of the carapace gives it the facies of a *Liomera*, but it differs widely from that genus and its immediate allies in the proportionate width of the fronto-orbital border, a character which would refer the species to the neighbourhood of *Xanthodes* in the sub-family Chlorodinæ of Alcock's classification. The massive chelipeds recall those of the Trapezioida, but in this character *Liomera longimana* A. M.-E. (Crust. Miss. Sci. Mexique, p. 240, pl. xlv. fig. 1) makes some approach to the new species.

Lt.-Col. Alcock, F.R.S., to whom I have fortunately been able to submit the specimens of this crab, tells me that he considers *Liomera sodalis* Alc. (Jour. Asiatic Soc. Bengal, lxvii. (2) p. 88, 1898) to be probably congeneric with it.

*LIOXANTHODES ALCOCKI*, sp. n. (Plate LXXII. figs. 1-3.)

Carapace a little less than twice as broad as long, strongly convex antero-posteriorly, slightly so from side to side; surface smooth and polished, without inter-regional markings except for a shallow meso-gastric groove and a pair of crescentic depressions parallel to the inner edges of the orbits. The greatest width is well in front of the middle of the carapace and the straight postero-lateral margins are strongly convergent. The strongly arched antero-lateral margins show the faintest possible traces of three teeth or lobes, and in front of the second and third of these on the dorsal surface is a shallow pit in which are set a few hairs. The front is very much deflexed and its margin is one-third of the width of the carapace or a little less; there is a shallow median notch, and the lateral lobes are nearly straight and not separated from the inner supra-orbital angles. The orbits are very large, and the eyes, when retracted, are incompletely hidden; the fronto-orbital width is about two-thirds of the width of the carapace.

The basal antennal segment is short and broad, reaching to the inner sub-orbital angle but not to the front. It appears to touch a small downward process from the front.

The endostome has a pair of very slight ridges which do not nearly reach its front margin.

The exopod of the third maxillipeds is about half as wide as the ischium; the merus is broader than long; the ischium has a longitudinal groove.

The chelipeds are very massive and very unequal in both sexes;

a considerable part of the length of the merus projects beyond the carapace and its margins are smooth; the carpus has a blunt inner angle; in the larger cheliped the palm is slightly compressed, about three-fourths as high as long, its outer surface with longitudinal rows of low, smooth tubercles; the fingers are short, the immovable one only about one-fourth as long as the lower edge of the palm; both fingers are furrowed and toothed, with a good deal of hair on the inner edges, not excavated at the tips. The smaller cheliped is more slender, its outer surface nearly smooth.

The walking legs have the segments rather broad and flattened and beset with longish hairs, especially distally.

In the male the third, fourth, and fifth abdominal somites are coalesced.

Colour (in spirit) dark brown, marbled on the posterior part of the carapace and on the limbs with yellowish; under parts yellowish. The chelipeds have a longitudinal whitish band on the outer surface of the hand.

In the larger of two ovigerous females the carapace measures only 2.2 mm. in length by 4.2 mm. in breadth, so that the species is one of the smallest of the Brachyura. The eggs are about .35 mm. in diameter.

#### Family GRAPSIDÆ.

*SESARMA MURRAYI*, sp. n. (Plate LXXII. figs. 4, 5.)

Carapace moderately convex, much broader than long, the four post-frontal lobes not prominent, sub-equal; except for a deep transverse groove between the gastric and cardiac regions the inter-regional grooves are not defined; the whole surface is covered with sharply-marked transverse striæ, becoming oblique on the branchial regions and breaking up into rows of minute granules anteriorly. Front more than half the width of the carapace, nearly straight as seen from above. Lateral margins strongly convergent posteriorly, without teeth behind the orbital angle.

Chelipeds a little larger in the male than in the female. The anterior margin of the merus is expanded, finely serrated for the greater part of its length and cut into two or three large teeth distally. The outer surface of the merus and carpus is transversely striate, the striæ microscopically beaded. The outer surface of the hand is nearly smooth except for a fine longitudinal line near the lower border; the upper surface has a longitudinal line running along its whole length with a number of oblique lines on the inner side. In some specimens a few fainter oblique lines are also present on the outer side. All these lines, although sharply cut, are very fine and are microscopically beaded. The upper surface of the dactylus is rounded and quite smooth except for a few very fine oblique beaded lines near the base in both sexes.



The merus of the walking legs has two or three strong teeth at the distal end of its hinder edge and, in addition, the merus of the last pair has two smaller teeth side by side near the proximal end. The legs carry rather long hairs and the dactylus is strongly spined.

Measurements :—

	Male.	Female (ovigerous).
Length of carapace.....	4.5 mm.	3.75 mm.
Breadth of        „        .....	6.6   „	5.75   „
(between orbital angles)		
Breadth of front .....	3.75   „	3.0   „

Remarks:—Assuming that the fine beaded lines on the upper surface of the hand represent the “pectinated ridges” found in the males of some other species of *Sesarma*, this little species will fall into the third section or sub-genus (*Parasesarma*) in de Man’s classification of the genus. Within this section it comes into relation with a group of species, all of small size, which are distinguished by the toothed meropodites of the walking legs. So far as I am aware only four species of this group have been described—*S. vestita* Stimpson\*, *S. andersoni* de Man, *S. edamensis* de Man, and *S. batavica* Moreira (= *S. barbimana* de Man, nec Cano). In all of these the pectinated ridges on the upper surface of the hand are more strongly developed than in the new species and are differently arranged; the upper edge of the dactylus of the chelipeds is strongly “milled” in all except *S. vestita*, where it is stated to be acute; and none of the species possesses teeth at the proximal end of the merus of the last pair of legs. Further, *S. batavica* is distinguished by the tufts of hair on the fingers, *S. edamensis* by the much broader legs, *S. andersoni* by having the carapace smooth and the sides much less strongly convergent posteriorly, and *S. vestita* by having the carapace only a little longer than broad (breadth-ratio 1.03 as against 1.46 to 1.53 in the new species). Outside of de Man’s third section, the only species of *Sesarma* which are described as having the meropodites of the legs toothed are *S. minuta* de Man and *S. barbimana* Cano, both of which are separated from the species here described by the presence on the lateral margin of a tooth behind the orbital angle.

The specimens of this crab were collected on the shore at Flying-fish Cove.

The specific name is chosen in compliment to Sir John Murray, K.C.B., F.R.S., by whom the specimens described in this paper have been presented to the British Museum.

\* This is referred by de Man to his first section (Zool. Jahrb. ii. p. 644, 1887), but the recently published description and figure (Stimpson’s Rep. Crust. N. Pacific Expl. Exp., Smithsonian Miscell. Coll. xlix. p. 136, pl. xiii. fig. 6, 1907) show that the species possesses pectinated ridges on the upper surface of the hand and must be referred to de Man’s third section.

## Family GECARCINIDÆ.

GECARCOIDEA LALANDII Milne-Edwards.

*G. lalandii* Ortmann, Zool. Jahrb., Abth. Syst. vii. p. 738 (1893).

To the synonymy given by Ortmann the following are to be added:—

*Hylæocarcinus natalis* Pocock, P. Z. S., 1888, p. 561.

*Pelocarcinus humei* (Wood-Mason) Alcock, Jour. Asiatic Soc. Bengal, lxix. pt. 2, p. 449 (1900).

*Gecarcinus lagostomus* (in error) Andrews, Monogr. Christmas Island, p. 163 (1900).

An examination of the Museum collection of Gecarcinidæ gives no reasons for dissenting from the synonymy which Ortmann has established for this species. The specimen recorded under this name from "S. America" by Adam White in the "List of Crustacea in the British Museum," p. 32 (1847), cannot now be traced, but a Museum copy of the List contains a note in the handwriting of Mr. Miers, "Certainly not this species," so that no confirmation is afforded of Milne-Edwards's statement that the type of the species came from Brazil.

With reference to the erroneous determination of the specimens recorded in the 'Monograph of Christmas Island' (a determination for which Dr. Andrews was not responsible) it is desirable to point out that there is no trustworthy evidence for the occurrence of *Gecarcinus lagostoma* outside the Atlantic area. Milne-Edwards indeed originally described that species as "rapporté de l'Australasie par MM. Quoy et Gaimard" (Hist. Nat. Crust. ii. p. 27, 1837), and Miers refers to a series in the British Museum obtained in the same region during the voyage of the 'Erebus' and 'Terror' (Challenger Rep. Brachyura, p. 219 footnote, 1886). With regard to the latter I can obtain no confirmation of the locality from the Museum registers. The specimens date from a time when the records of locality were less strictly kept than they are now, and it seems possible that specimens arriving at the Museum without indication of locality may have been assumed to come from the same region as the type-specimens. Miers also mentions a specimen from the Cape of Good Hope, and I may add that there is another in the collection labelled "Madagascar" but in neither case can the history of the specimens be traced.

Dr. Andrews has described (*l. c.*) the annual migration of *G. lalandii* to the sea during the rainy season for the purpose of hatching off the eggs. On his visit to the island in 1908, he obtained specimens of a large *Megalopa*-larva which occurred in enormous quantities in the sea shortly after the migration, and also of a small crab which appeared in similar numbers at a slightly later date. It seems practically certain that these larvæ and young can belong to no other species than *G. lalandii*, and it

is hoped that it may be possible to obtain the earlier stages and to give a complete account of the life-history.

CARDISOMA HIRTIPES Dana.

*Cardiosoma hirtipes* Alcock, Jour. Asiatic Soc. Bengal, lxix. pt. 2, p. 447 (1900).

*Cardisoma carnifex* (Herbst) Andrews, Monogr. Christmas Island, p. 164 (1900).

Miss Rathbun has recently employed for this species the name *C. rotundum* Quoy & Gaimard (Bull. U. S. Fish Comm. for 1903, pt. iii. p. 838, 1906), but, so far as I know, she has not explained in detail her reasons for doing so. The figure to which she refers (Freycinet's Voyage autour du Monde, Atlas Zool. pl. 77. fig. 1, 1825) is very poor, and there seems no obvious reason for taking it to represent this species rather than *C. carnifex*.

The account which Dr. Andrews has given (*l. c.*) of the habitat of this species—in deep burrows by the side of freshwater streams—agrees with what Ortmann has recorded (Zool. Jahrb., Abth. Syst. x. p. 339, 1897) of the closely allied *C. carnifex* in East Africa. Dr. Andrews tells me that he never saw this species at or near the sea (in marked contrast to *Gecarcoidea*), which also coincides with Ortmann's experience. Since nothing appears to be recorded of the breeding habits of the species of this genus, it may be worth while to mention that in the West African *C. armatum* (the only species of which the Museum possesses an ovigerous female) I find the young within the minute eggs to be in the zoea stage. There can be little doubt therefore that in this genus also the young stages are passed in the sea.

#### Family MAIIDÆ.

HYASTENUS ANDREWSI, sp. n. (Plate LXXII. figs. 6, 7.)

Carapace and limbs closely covered with long, thick, soft hairs which, on the walking legs and especially on the merus and carpus of the first two pairs, fringe the anterior and posterior margins and make the limb appear broad and flat. The carapace is triangular, with a convex posterior margin and, when denuded of hair, is smooth and polished, with a single low tubercle on each side of the gastric region. The gastric, cardiac, and intestinal regions are strongly convex, defined by well-marked grooves. The rostral spines are less than a quarter of the total length, coalesced for some distance in front of the orbits, deflexed at the base and curving upwards at the tip. The supra-orbital margin is not very prominent and its anterior corner is rounded off. The basal segment of the antenna is little expanded so that the floor of the orbit is very incomplete, and is without tubercle or spine at its anterior end; the free segments of the antenna are visible at the side of the rostrum and are beset with long hairs. The first

pair of walking legs are a little longer than the carapace and rostrum. The dactyli are slender, curved, and very sharp-pointed, with two or three teeth near the base on the lower edge.

An ovigerous female specimen measures 12 mm. in length to base of rostral spines, by 9 mm. across the widest part of the carapace.

Remarks:—This little crab, which I have failed to identify with any described species, differs from the usual type of *Hyastenus* by the comparatively slight development of the supra-orbital margin. In this character and in the narrowness of the basal antennal segment it seems to approach the American genus *Pelia*, from which, however, it differs in the absence of a tooth at the distal end of the same segment. As there are considerable differences in the relative development of these parts in the various species of *Hyastenus*, the new species may provisionally be placed in that genus.

*HYASTENUS UNCIFER*, sp. n. (Plate LXXII. figs. 8, 9.)

Carapace sub-pyriform, pointed behind, tomentose, tuberculate. There is a transverse row of five tubercles (the outer pair the largest) on the gastric region and, behind this, a single median tubercle; the cardiac region is convex and the intestinal region bears two tubercles, the posterior one acute and recurved; there is a very prominent hepatic spine, and the branchial regions bear each several tubercles and a procurved epibranchial spine. The rostral horns are equal to, or a very little shorter than the carapace (in the male), slender, divergent, and gently decurved. The supra-ocular eave is acutely produced anteriorly; there is no intermediate tooth between it and the post-ocular process, which is not expanded distally. The basal antennal segment has a sharp spine at the antero-external angle.

The chelipeds (in the female) are slender, with two or three spines on the carpus; the fingers are less than half the length of the palm and meet for the greater part of their length.

The walking legs are slender, with a few granules on the carpus, and with the dactylus armed with a row of stout recurved spines.

A female specimen measures 11 mm. in length to the base of the rostral spines.

Remarks:—In the length of the rostral horns this species approaches *H. brockii* de Man, but has the carapace more tuberculate and more pointed behind. The very prominent hepatic spine and the strong hooked teeth on the dactyli of the walking legs are unlike those of any species with which I have been able to compare it.

*TYLOCARCINUS GRACILIS* Miers.

*T. gracilis* Miers, Ann. Mag. Nat. Hist. (5) iv. p. 15 (1879).

In describing this species, Miers suggested that it might "perhaps prove to be only a variety" of *T. styx* (Herbst). The numerous specimens collected by Dr. Andrews, however, show no



perceptible approximation to *T. styx* as compared with Miers's type specimens. The long, straight, rostral spines, divergent from the base, and the more numerous and longer spines on the legs, are characters which seem to justify the separation of the species. I do not find, however, that the carapace is "much narrower" than in *T. styx*, and the rostral spines are not always more than half the length of the carapace. Dr. Andrews's collection includes some males in the breeding phase, with enlarged chelæ and widely gaping fingers.

PERINEA TUMIDA Dana.

*Perinea tumida* Dana, Crust. U.S. Expl. Exp. i. p. 114, pl. iv. figs. 1 a-f (1855); Rathbun, Bull. U.S. Fish Comm. for 1903, pt. iii. p. 881 (1906).

*Parathoë rotundata* Miers, Ann. Mag. Nat. Hist. (5) iv. p. 16, pl. v. figs. 2, 2 a (1879); Haswell, Cat. Austral. Crust. p. 30 (1882); Klunzinger, Spitz- und Spitzmundkrabben des Roten Meeres, p. 45, pl. i. figs. 7 a-d, text-fig. 10 (1906).

About 18 specimens of a little crab collected by Dr. Andrews are identical with the types of Miers's *Parathoë rotundata* from Port Curtis and Fiji. The rostral teeth, although short, are much more prominent than in Miers's figures and are separated by a rounded notch, and there is a small tooth at the distal end of the basal segment of the antenna unnoticed by Miers.

There can be little doubt, however, that Miers's genus and species are synonymous with those of Dana, quoted above. By the courtesy of Miss Rathbun I have been able to examine a specimen from Laysan recorded by her (*l. c.*) as *Perinea tumida* Dana. It is a large male in which, as in the large female from the Gulf of Suez mentioned by Miers, the tubercles on the carapace are rather less prominent than in smaller specimens, but it undoubtedly belongs to the same species. In addition to the differences from Dana's account mentioned by Miss Rathbun, it is to be noted that the rostral teeth are much less prominent than in the original figures and the notch between them is rounded instead of angular. The tooth at the end of the basal segment of the antennules is also less prominent. I see no reason, however, to dispute Miss Rathbun's identification of the Laysan specimen with Dana's species and if this be accepted the name given by Miers must be placed as a synonym.

EXPLANATION OF PLATE LXXII.

- Fig. 1. *Lioxanthodes alcocki*, g. et sp. n. Female, dorsal view.  $\times 9$ .  
 2. " " Anterior part of body, ventral view.  $\times 18$ .  
 3. " " Larger chela of male, from outer side.  
 4. *Sesarma murrayi*, sp. n. Male, dorsal view.  $\times 6$ .  
 5. " " Upper surface of chela.  
 6. *Hyastenus andrewsi*, sp. n. Male, dorsal view.  $\times 3$ .  
 7. " " Orbital region from below.  
 8. *Hyastenus uncifer*, sp. n. Female, dorsal view.  $\times 3$ .  
 9. " " Dactylus of leg of last pair.

4. An Abnormal Individual of the Echinoid *Amblypneustes*.

By H. L. HAWKINS, B.Sc., Mark Stirrup Scholar in the University of Manchester\*.

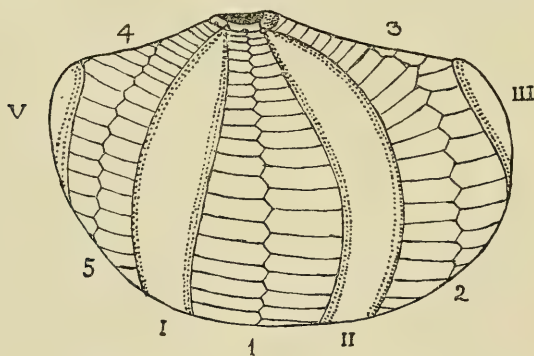
[Received June 2nd, 1909.]

(Text-figures 226-230.)

A series of the recent Echinoid *Amblypneustes* from Australian waters, preserved in the Manchester Museum, includes an individual, apparently of *A. ovum*, with a particularly fundamental abnormality, which seems worthy of brief description.

Abnormalities in the symmetry of species of *Amblypneustes* were described in 1880 by F. J. Bell and C. Stewart in the Journal of the Linnæan Society (vol. xv. pp. 126 & 130, pl. v.), and it would appear that the genus is one the members of which are especially liable to irregularities of development. The structural peculiarities of my specimen, however, are of a type distinct from those described in the papers referred to, and resemble those in the *Echinus esculentus* figured by Messrs. J. Ritchie and D. C. McIntosh in the Proceedings of the Zoological Society for 1908 (p. 646, pl. xxxiii.).

Text-fig. 226.



Lateral view of test of an abnormal *Amblypneustes*.

The outward form of the specimen is strikingly irregular. Instead of the regular ovoid shape of other specimens of the species, it is much elongated along a line almost corresponding with the antero-posterior axis. The lateral view (text-fig. 226) shows the test to be abruptly truncated adapically, while the apical system of plates rises boldly above the partly concave slopes of the corona.

The adapical view (text-fig. 227) shows the remarkable feature that only three ambulacral areas reach the apical system, the two

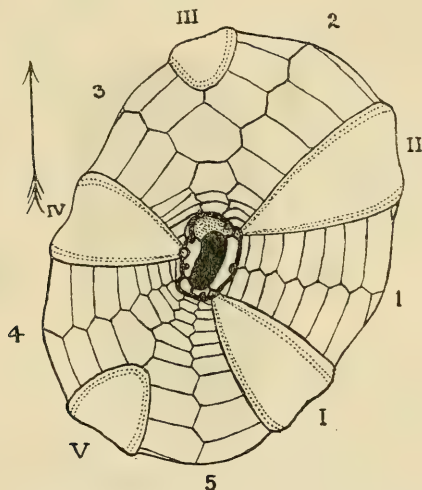
\* Communicated by F. A. BATHER, F.R.S.

others, the anterior and left-posterior, being rounded off a little above the ambitus. The apical system is elongated in two directions as though to meet the defaulting ambulacra, but in each case a considerable length of non-poriferous plates intervenes between the adapical extremities of the two ambulacra and the plates from which they should spring.

The other three ambulacra show no departure from the normal type, except that the left-anterior (IV) is sensibly wider than either of the others, and less convex in longitudinal outline.

The right posterior interambulacrum (1) is the only one of normal character throughout, the other four being more or less modified adapically to counteract the absence of the ambulacra. The adoral region of the test is perfectly normal, and the peristomial aperture regularly decagonal.

Text-fig. 227.

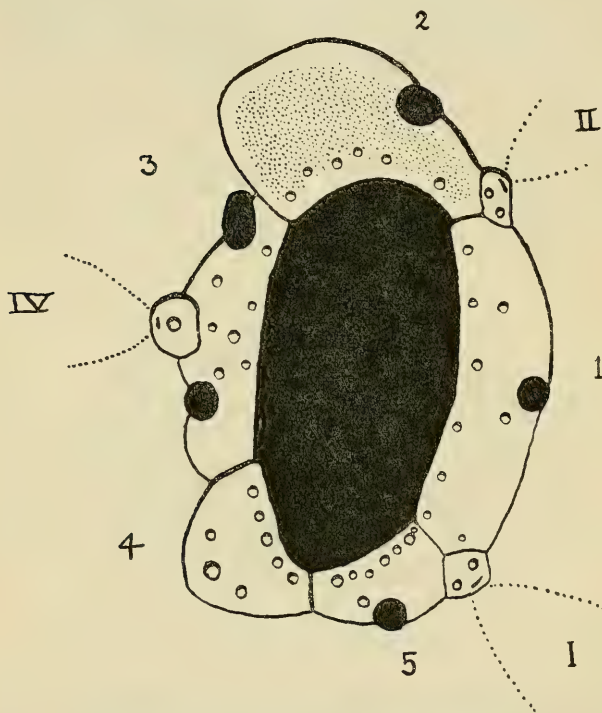
Adapical view of test of an abnormal *Amblypneustes*.

The apical system (text-fig. 228, p. 716), besides the lengthening already referred to, shows marked departures from the normal type. There are five genital plates, the inner margins of which enclose the elongated periproct, but they are of very unequal dimensions. The madreporite is large, and perforated on the right side by a small genital pore. The two adjoining genital plates on the right and left sides are elongated and depressed. The plate on the right is normally perforate, but that on the left bears two large gonopores, one near each end. The two posterior genital plates are short and convex, and closely applied to each other, forming an elevation that matches the anterior prominence of the madreporite. The right posterior plate is perforated in the usual way,

but its fellow on the left is imperforate. There are thus five genital pores distributed over four of the genital plates.

There are three ocular plates, corresponding with the termination of the three complete ambulacra; each is perforated by a minute pore. The ocular on the left is almost spherical in shape, since it abuts against the middle of the large genital (3), and not, as usual, against the two genitals (4 and 5). There is no trace of the other two ocular plates. The periproct is covered by numerous irregular plates of small size.

Text-fig. 228.



Apical system of an abnormal *Amblypneustes*.

The composition of the interambulacral areas (text-fig. 227, p. 715) differs in the two affected portions of the test. The two interambulacra 4 and 5 meet above the truncated end of ambulacrum V, and, except that the suture between the two areas is somewhat irregular, continue side by side up to the apical system as a compound area of four columns of plates.

The adaptation of interambulacra 2 and 3 to the changed conditions is different. Here column *b* of area 2, and column *a*

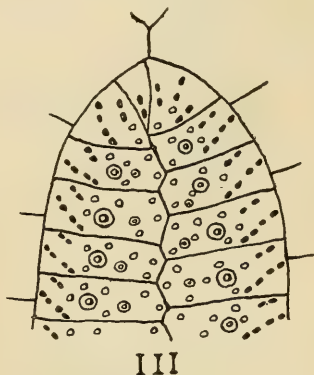
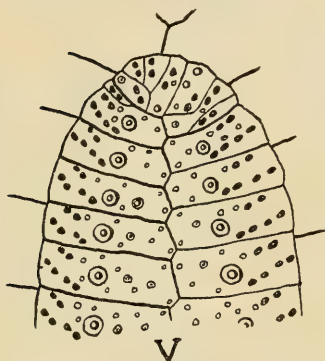


of area 3 are discontinued after they have wrapped round the adapical end of ambulacrum III, and their place is taken by a single median series of heptagonal and hexagonal plates, so that a compound area of three columns of plates abuts on the hypertrophied madreporite.

The structure of the ambulacra at and towards the ends of the truncated areas is shown in text-figures 229 and 230. The poriferous plates are seen to curve round the extremities of the zones with considerable regularity, leaving a regularly rounded outline rather than an abrupt break in the course of the growth of the area.

Text-fig. 229.

Text-fig. 230.

Abnormal ambulacra of *Amblypneustes*.

Counting from the peristome there are about 25 sets of plates in ambulacrum III, and about 28 in V. In a normal ambulacrum there are about 56.

The abnormal development, or rather, lack of development, in this specimen is quite similar to that noted by Messrs. Ritchie and McIntosh in *Echinus esculentus*, except that the retardation of ambulacral growth has affected two areas instead of one only. The development of fresh ambulacral plates seems to have been checked at a different period in the life of the animal in the case of each ambulacrum, and no such corresponding irregularities at about the same region of the other areas are to be found in the *Amblypneustes* as there were in the case of the *Echinus*. Thus the hypothesis of a uniform and temporary wound or disease affecting the growth of new plates round the apical system, which could account for the latter's abnormalities, does not seem tenable in this case. Moreover, the great irregularity in the numbers and proportions of the plates of the apical system seem to point to a more radical morbidity than is compatible with the idea of mere local injury.

It seems probable that the two missing ocular plates of the

apical system may have been resorbed, as they should have existed at the adapical extremities of the truncated ambulacra in the early and normal phase of the animal's existence. There is no sign of their having been carried down to remain in their terminal position at the ends of the ambulacra.

There is a small hole in the middle of interambulacrum 2 which does not look like a mere chance puncture inflicted after the death of the animal, as it seems to have been partly healed up by a fresh deposition of calcite from within. The hole may be the result of the activity of some boring parasite, but whether such an agent could cause the remarkable irregularities that exist in the test seems very doubtful.

The following are a few important measurements of the test:—

	mm.
Length (ant. rad. to post. interr.) . . . . .	36
Breadth (at right angles to above) . . . . .	31
Height (including apical system). . . . .	30
Ambitus . . . . .	115
Diameter of peristome . . . . .	10
Length of apical system . . . . .	7·75
Breadth of apical system . . . . .	5
From rad. III to nearest point of apical system .	14·5
"    "    V    "    "    "    "    "    "	10

# 5. The Decapods of the Genus *Gennadas* collected by H.M.S. 'Challenger.' By STANLEY KEMP, B.A.\*

[Received June 7, 1909.]

(Plates LXXIII.—LXXV.†)

In 1881 ‡, Spence Bate established the genus *Gennadas* for the reception of certain abyssal Penæidæ found by the 'Challenger' Expedition. He recognized two species, *G. parvus* and *G. intermedius*, but his descriptions and figures, viewed from the standpoint of our present knowledge, are hopelessly inadequate. Since 1888, when the full Report on the 'Challenger' Crustacea Macrura appeared, several authors have recorded *Gennadas parvus*, but owing to the imperfections in the original description it may be doubted whether much reliance can be placed on their determinations.

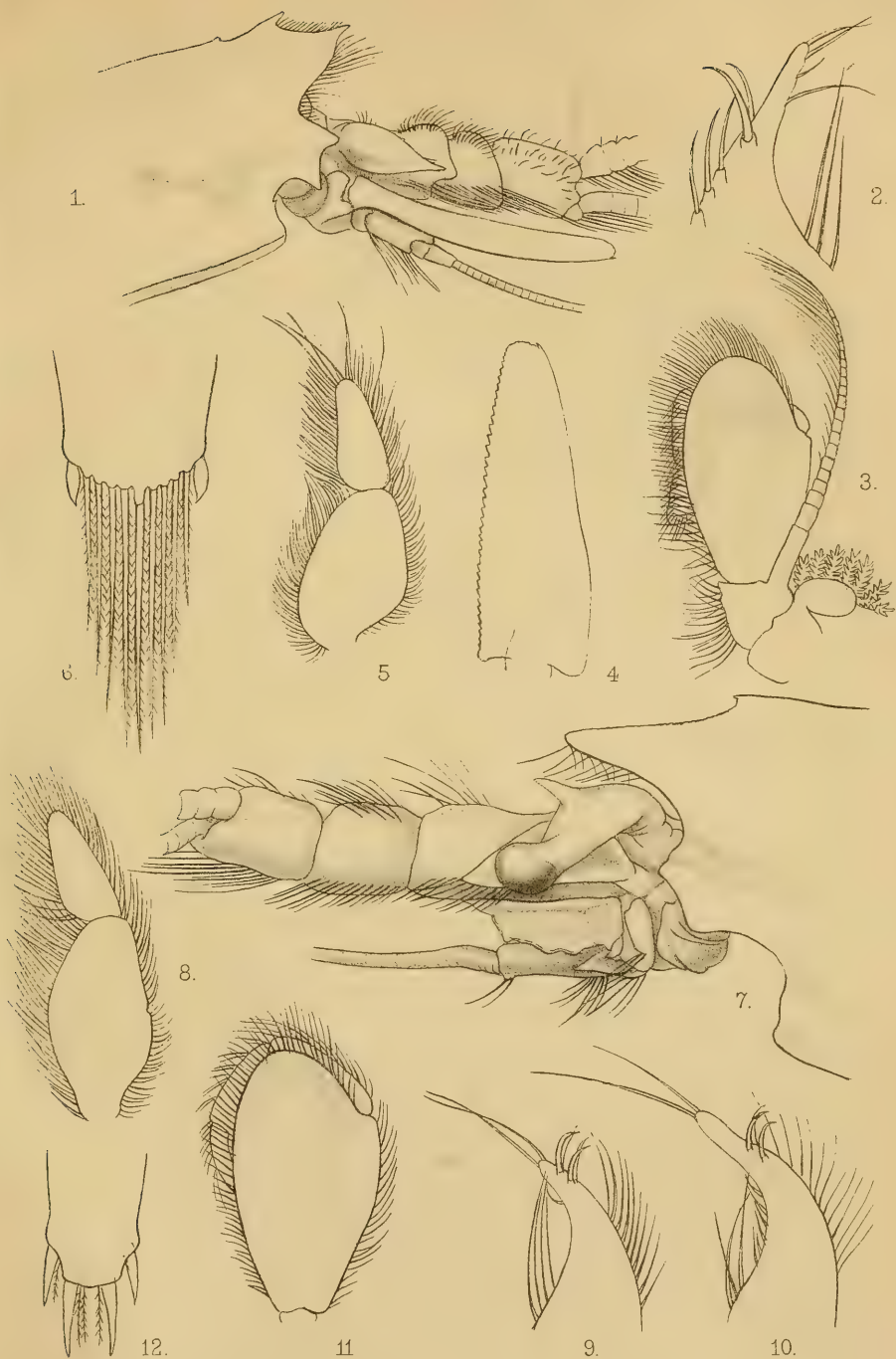
Only quite recently has any good basis been formed for future work. Bouvier, in 1906 §, outlined a scheme for the identification of six Atlantic species and emphasized the value of several characters as specific determinants; by means of these species he

\* Communicated by Dr. W. T. CALMAN, F.Z.S.

† For explanation of the Plates see pp. 729 & 730.

‡ Ann. Mag. Nat. Hist. Sept. 1881, p. 91.

§ Bull. Mus. Océanog. Monaco, 80, 1906.



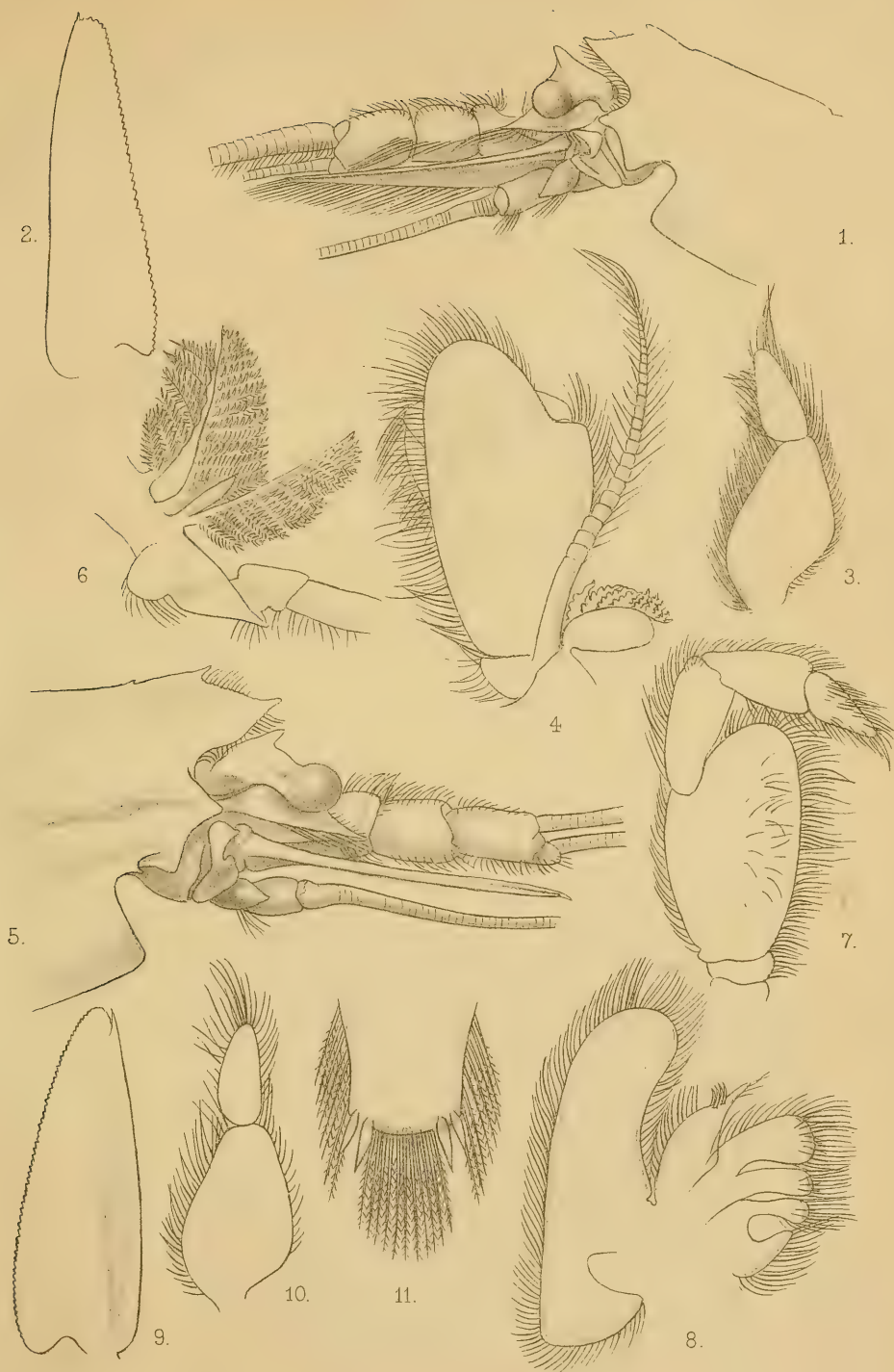
G.M. Woodward del. et lith.

West, Newman imp.

1-6. GENNADAS PARVUS.  
7-12. GENNADAS INTERMEDIUS.







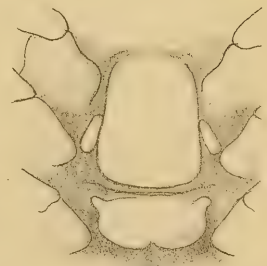
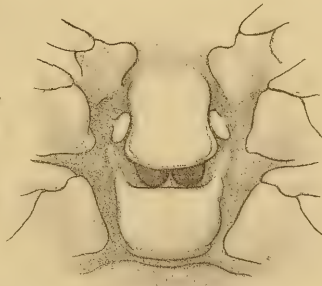
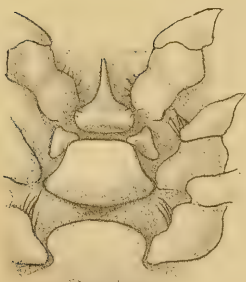
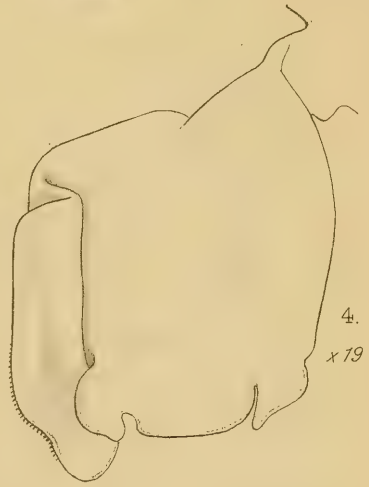
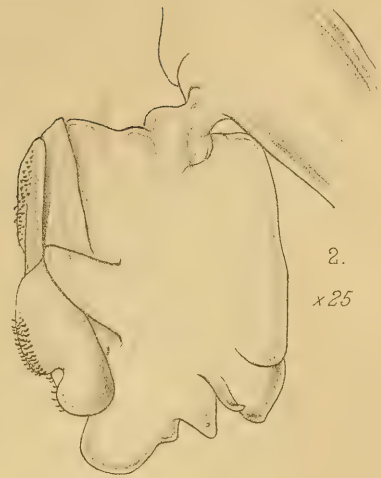
G.M.Woodward del. et lith.

West, Newman imp.

1-4. GENNADAS BOUVIERI.

5-11. GENNADAS CALMANI.





5.  $x 7\frac{1}{2}$   
G.M. Woodward del. et lith.

West, Newman imp.

1 GENNADAS PARVUS. 3. GENNADAS INTERMEDIUS.  
2. GENNADAS SCUTATUS 4-5 GENNADAS CALMANI.  
6-7 GENNADAS BOUVIERI.





was able to trace the derivation of the genus from the more primitive *Benthescymus*. This short paper was followed in 1908\* by a lavishly illustrated memoir on the Penæidæ collected by the Prince of Monaco, containing fuller treatment of the same species in addition to valuable information on other genera. These two papers have greatly facilitated any further work on the subject and the revision of the 'Challenger' material has in consequence been robbed of much of its difficulty.

Before going further it is, however, necessary to refer to the generic status of the species belonging to this group. In 1882† S. I. Smith described, under the name of *Amalopenæus*, a genus which differs from Spence Bate's *Gennadas* only in the total suppression of the podobranchs on the first three pairs of pereopods. For some time it was thought that Spence Bate's determination of the branchial formula was incorrect—a not unreasonable hypothesis; Alcock, however, stated in 1901 that these gills were present in certain specimens of *Gennadas* from Indian waters, and an examination of the type species in the British Museum establishes the correctness of Spence Bate's observation.

On the other hand, specimens of *Amalopenæus elegans* from the N.E. coast of America show no trace of these gills, thus confirming Smith's determination and that of several subsequent writers.

The question now arises whether the presence or absence of these gills is of itself a factor of sufficient importance to justify the retention of two distinct genera—for it is almost certain that no other characters are available for their separation. Although the literature of the subject contains numerous references to this question, Bouvier, strangely enough, makes no mention of it‡ in his memoir on the material collected by the 'Princesse-Alice.'

The nomenclature of the species is perhaps a matter of minor importance, if the relationships of the various forms are fully understood. Podobranchs are rarely found on the thoracic limbs of Decapoda Natantia; they are most frequently present in the Penæidea, and in such a tribe, which abounds in primitive characters, the absence of these gills is rightly regarded as a feature of great importance, for it indicates in no uncertain way the degree of specialization to which the species has attained§. I have consequently retained *Amalopenæus* as a distinct genus and consider Bouvier's group, *Benthescymæ*, to comprise three

\* Rés. Camp. Sci. Monaco, xxxiii. 1908.

† Bull. Mus. Comp. Zool., Harvard, vol. x. 1882.

‡ Bouvier (*loc. cit.*, 1908) regards *Amalopenæus* as a synonym of *Gennadas* and, in reference to the gill formula, merely states that it is the same as that of *Benthescymus*. This is certainly inaccurate for at least one of the species he was dealing with, viz. *Amalopenæus (Gennadas) elegans*.

§ Although the determination of the complete gill formula in these species is a matter of some difficulty, the presence or absence of podobranchs on the first three pereopods can be observed with the greatest ease. The podobranch in *Gennadas* (Pl. LXXIV. fig. 6) is an outgrowth from the base of the epipod; in *Amalopenæus* a considerable space intervenes between the epipod and the lowest gill (an arthrobranch).

genera, *Benthescymrus*, *Gennadas*, and *Amalopenæus*, the first being the most primitive and the last the most highly specialized.

The species of *Gennadas* and *Amalopenæus* are by no means easy of determination. The best characters are undoubtedly those afforded by the membranous expansion of the endopods of the first pleopods of the male (known as the *petasma*) and by the sternal plates of the cephalothorax (the *thelycum*) in the female.

These characters are of course of little value in very young specimens, but they appear to afford trustworthy indications in all examples upwards of one half the maximum length of the species.

So far as at present known there is extremely little variation in the form of the adult petasma, but this is not necessarily the case with the thelycum, for Bouvier (1908, *loc. cit.*) has instanced several variations in the case of *Amalopenæus valens*, Smith. Although it might be expected that seasonal variations depending on the degree of sexual maturity of the individual would be manifest in both thelycum and petasma, it must be noticed that there is no evidence of this in the case of *Amalopenæus elegans*, a species of wide Atlantic distribution and of common occurrence.

Bouvier has indicated other characters of great value in the determination of the different species. Of these, the most important are the form of the antennary and infra-antennary angles, the proportional length of the second and third joints of the antennular peduncle, the proportional lengths of the ultimate joint of the mandibular palp and of the merus, carpus, and chela of the first three pairs of pereopods. Valuable information is also afforded by the form of the antennal scale and by the presence or absence of a stout median spine on the first abdominal sternum.

The specimens referred by Spence Bate to *Gennadas parvus* and *G. intermedius* are for the most part fairly perfect; the majority of those recorded in the 'Challenger' Report are preserved in the British Museum, and the types of both species are extant. The specimens missing are four in number, viz. :—

St. 137. 35° 59' S., 1° 34' E. Recorded as *G. intermedius*.

St. 159. S. of Australia. }

St. 250. N. Pacific. }

St. 289. S. Pacific. }

Recorded as *G. parvus*.

The result of an investigation of the remaining specimens, seventeen in number, is indicated in the table on p. 721.

If these results be accepted, it will be seen that Spence Bate was quite as unfortunate in his treatment of this genus as Hansen has shown him to have been with *Sergestes*.

In the following systematic notes no attempt has been made to correct the many inaccuracies which disfigure Spence Bate's work. The condensed descriptions and figures will, it is hoped, prove sufficient for the recognition of the type species and the two forms described as new. The various shapes assumed by the lobes and folds

Spence Bate's identification.	Station.	Locality.	Sex.	Author's identification.
<i>Gennadas parvus</i> .....	45	M. of Delaware R.	♂	<i>Amalopenæus elegans</i> , Smith.
	101	Off Sierra Leone.	♂	Not determined.
	120	Off Pernambuco.	♂	<i>Gennadas intermedius</i> , Sp. Bate.
	206	Off Manila.	♂	<i>Gennadas bouvieri</i> , n. sp.
	220	N. of New Guinea.	♂	
	do.	do.	♂	Not determined.
	do.	do.	♂	
	230	S. of Japan.	♂	TYPE.
	232	do.	♂	<i>Gennadas calmani</i> , n. sp.
	do.	do.	♂	
<i>Gennadas intermedius</i> }	do.	do.	♂	
	do.	do.	♂	
	235	do.	♂	<i>Gennadas scutatus</i> , Bouvier.
	237	Off Yokohama.	♂	
	267	N. Pacific.	♂	
	106	Off Sierra Leone.	♂	TYPE.
	?	Off Bermuda.	♂	Not determined.

of the petasma are so complicated that they almost defy adequate textual treatment; the necessary information is consequently conveyed solely by the figures.

All that is at present known of the habits of *Gennadas* and *Amalopenæus* goes to prove that they are free-swimming forms which never live on the ocean bottom. It is probable that all the specimens found by the 'Challenger' were caught during the ascent of the net; the depths given can therefore be accepted only as indications of the soundings at the different stations.

GENNADAS PARVUS Spence Bate. (Plate LXXIII. figs. 1-6; Plate LXXV. fig. 1.)

*Gennadas parvus*, Sp. Bate, Ann. Mag. Nat. Hist. Sept. 1881, p. 192, and 'Challenger' Crustacea Macrura, 1888, p. 340, pl. lix.

? *Gennadas parvus*, Wood-Mason, Ann. Mag. Nat. Hist. Feb. 1891, p. 189, and Oct. 1891, p. 286.

? *Gennadas parvus*, Alcock, Desc. Cat. Indian Deep Sea Macrura, 1901, p. 46.

? *Gennadas parvus*, Rathbun, U.S. Fish Comm. Bull. for 1903 (publ. 1906), p. 907, fig. 60.

St. 230. S. of Japan. 26° 29' N., 137° 57' E. Trawl. 2425 fathoms. One male, the type specimen, 25 mm.\*

The rostral crest (Pl. LXXIII. fig. 1) is elevated above the dorsal carina of the carapace; its frontal margin is rather strongly convex. It bears the usual fringe of setæ between the apex and the dorsal spine, while behind the latter there is a small tubercle situated on the dorsal carina of the carapace. Both the antennary

\* Measured from the apex of the rostrum to the tip of the telson.

and infra-antennary angles are strongly acute and a very small branchiostegal spine is present. The distance between the cervical and post-cervical grooves, measured dorsally, is about one-third the distance from the post-cervical groove to the hinder edge of the carapace. The mid-dorsal carina is not evident behind the latter groove.

The eyes are in very poor condition, one missing and the other badly damaged. The second joint of the antennular peduncle is very short; measured dorsally it is less than half the length of the ultimate segment. The antennal scale (Pl. LXXIII. fig. 4) is three times as long as broad and not much narrowed apically; the convex outer margin terminates in a minute spine, which hardly extends as far forward as the lamella.

The ultimate joint of the mandibular palp (Pl. LXXIII. fig. 5) is fully as long as the width of the first joint. In the second maxilla the anterior lobe of the internal lacinia is not constricted behind its apex and is not narrower than the adjacent lobe of the external lacinia. In the latter lacinia the anterior lobe is about one and a half times the width of the posterior. The endopod (Pl. LXXIII. fig. 2) is furnished with two stout curved spines behind the apex, beyond which the narrow distal prolongation bears four setæ on the inner margin. The endopod of the first maxillipede reaches slightly beyond the exopod. The third segment is one and a quarter times the length of the second; the fourth segment is extremely minute. Three stiff curved spines are situated on the inner distal margin of the basal joint. In the second maxillipede the merus (Pl. LXXIII. fig. 3) is rather less than twice as long as broad; its anterior prolongation (*i. e.* the portion extending beyond the insertion of the carpus) is about one-third the total length of the segment.

The first pair of pereopods is missing. In the second pair the carpus is nearly half as long again as the chela, and the dactylus is distinctly shorter than the palm. The carpus of the third pair is exactly the same length as the merus and more than twice the length of the chela; the dactylus is slightly shorter than the palm.

The abdomen is carinate only on the sixth somite and the median spines on the sterna are all very blunt and inconspicuous. On the lower margin of the telson there are basally two rounded lobes. The apex (Pl. LXXIII. fig. 6) is rather broad and convex. A short stout spine marks each outer angle; between these there are nine plumose setæ of which the middle one is the longest.

The petasma is very complex; its numerous lobes and folds are shown in Pl. LXXV. fig. 1.

This species bears a close superficial resemblance to *Amalopenxus elegans*\*. Apart from the generic character—the presence

\* My statement (Fisheries, Ireland, Sci. Invest. for 1905, V. 1906) that *G. parvus* and *A. elegans* are synonymous I now regard as erroneous. The mistake is probably traceable to the close resemblance of the two forms and to the fact that an authentic example of *A. elegans* occurs in the collection under the name of *G. parvus*.



of podobranchs on the first three pairs of pereopods—*G. parvus* is distinguished by the greater distance between the cervical and post-cervical grooves, by the strongly acute infra-antennary angle, by several details in the oral appendages, and by the form of the petasma.

GENNADAS INTERMEDIUS Spence Bate. (Plate LXXIII. figs. 7–12; Plate LXXV. fig. 3.)

*Gennadas intermedius*, Sp. Bate, 'Challenger' Crustacea Macrura, 1888, p. 343, pl. lviii. fig. 3.

St. 106. Off Sierra Leone. 1° 47' N., 24° 26' W. Trawl. 1850 fathoms. One male, the type specimen, ca. 48 mm.

St. 120. Off Pernambuco. 8° 37' S., 34° 28' W. Trawl. 675 fathoms. One male, ca. 46 mm.\* (sub *G. parvus* Sp. Bate.)

This species is evidently one of the more primitive species of *Gennadas*, and is closely allied to *G. alicei* Bouvier. Both the specimens are unfortunately in bad condition.

The rostral crest (Pl. LXXIII. fig. 7) is only slightly elevated above the dorsal carina of the carapace, presenting a marked contrast to that found in the preceding species. The inferior margin is not convex. The fringe of setæ between the apex of the rostrum and the dorsal spine was evidently present originally, although scarcely a trace of it now remains. The antennary and infra-antennary angles are both bluntly rounded and very obtuse; the emargination between them is shallow, but not altogether missing as in *G. alicei*. The branchiostegal spine is wholly absent in the type specimen, but an exceedingly minute point is visible on one side of the second example. The hinder part of the carapace is distorted and crushed in both specimens; the distance between the cervical and post-cervical grooves (measured dorsally) is however great, probably one-half the distance from the post-cervical groove to the hinder margin of the carapace. The mid-dorsal carina is traceable throughout the length of the carapace, although faint in the posterior half.

The eyes are in bad condition, but the width across the cornea seems to be less than in *G. alicei*. The second joint of the antennular peduncle, measured dorsally, is equal in length to the third joint. The antennal scale is broken in every instance, but it is evident that it is not strongly narrowed apically.

The distal joint of the mandibular palp (Pl. LXXIII. fig. 8) is slightly longer than the width of the first joint. In the second maxilla the anterior lobe of the internal lacinia is constricted behind its apex, and is distinctly broader than the adjacent lobe of the external lacinia. In the latter lacinia the anterior lobe is fully one and a half times the width of the posterior lobe. The apex of the endopod has not exactly the same character in the two

\* In the bottle with this specimen there is a label in Dr. Hansen's writing, which reads—"Agrees with the type of *G. intermedius*, Bate, not with *G. parvus*."

specimens. In the type (Pl. LXXIII. fig. 9) there are four curved dorsal spines, two long setæ at the apex of the short distal prolongation and one short spine on the inner margin. In the second example (Pl. LXXIII. fig. 10) there are three dorsal spines, a much longer distal prolongation, and six short spines on the inner margin.

The endopod of the first maxillipede falls short of the apex of the exopod. The oval third joint is twice the length of the second; the fourth joint, when present, is very minute. The basal joint bears two curved spines on its inner distal margin. The merus of the second maxillipede (Pl. LXXIII. fig. 11) is rather less than twice as long as wide, and its anterior prolongation is not more than one-quarter the total length of the joint.

In the first pair of pereopods the carpus, which is about the same length as the chela, is three-quarters the length of the merus. In the second pair the carpus is one and a half times as long as the chela, while the dactylus is evidently shorter than the palm. The carpus of the third pair is fully as long as the merus, the chela is about half the length of the carpus, and the dactylus is considerably shorter than the palm.

Each of the abdominal sterna bears a blunt and inconspicuous tubercle; the sixth somite alone is dorsally carinate. The lower margins of the telson are bluntly bilobed at the base. The apex is broken in the type; in the second specimen (Pl. LXXIII. fig. 12) it is narrow, truncate, and is armed with a pair of stout spines at each outer angle, between which are four plumose setæ.

The petasma (Pl. LXXV. fig. 3) is almost identical in the two specimens.

The resemblance of this species to *Gennadas alicei* is very marked, and it is by no means improbable that the two forms will eventually turn out to be specifically identical; in this case the name given by Spence Bate claims priority.

The chief points of difference between *Gennadas intermedius* and Bouvier's description and figures of *G. alicei* lie in the presence of a rather obscure infra-antennary angle in the former species, and in the forms assumed by the internal lacinia of the second maxilla and by the merus of the second maxillipede. The petasmata of the two species are similar.

GENNADAS CALMANI\*, sp. n. (Plate LXXIV. figs. 5-11; Plate LXXV. figs. 4 & 5.)

St. 232. S. of Japan. 35° 11' N., 139° 28' E. 345 fathoms. Two males, two females, 49-56 mm.

St. 236. S. of Japan. 34° 7' N., 138° E. Trawl. 565 fathoms. One female, 55 mm.

St. 237. Near Yokohama. 34° 37' N., 140° 32' E. Trawl. 1875 fathoms. One female, 53 mm.

\* This species is associated with the name of my friend Dr. W. T. Calman, to whom I am indebted for much valuable advice and for every facility for work during my visit to the British Museum.

The rostral crest (Pl. LXXIV. fig. 5), except for the greater prominence of the dorsal and apical spines, agrees closely with that of *G. parvus*. The antennary and infra-antennary angles are both acute: the latter is rather more bluntly rounded than the former. The branchiostegal spine is prominent. The distance between the cervical and post-cervical grooves, measured dorsally, is less than one-third the distance from the post-cervical groove to the hinder margin of the carapace. Both the grooves are faint dorsally and do not interrupt the strong median carina which extends the whole length of the carapace.

The second joint of the antennular peduncle, measured dorsally, is fully three-quarters the length of the ultimate joint. The antennal scale (Pl. LXXIV. fig. 9) is rather less than three times as long as its greatest width and is remarkable for its extremely narrow apex. The convex outer margin terminates in a rather strong spine, which scarcely reaches as far forward as the lamella.

The ultimate joint of the mandibular palp (Pl. LXXIV. fig. 10) is a little shorter than the width of the basal joint. In the second maxilla (Pl. LXXIV. fig. 8) the anterior lobe of the internal lacinia is very strongly constricted behind the apex, but is not broader than the adjacent lobe of the external lacinia. The anterior lobe of the latter lacinia is very broad—about twice the width of the interior lobe. The tip of the endopod is long and narrow; it bears four terminal setæ and four curved dorsal spines behind the apex. The endopod of the first maxilliped reaches a little beyond the exopod. The third joint is practically twice the length of the second, and the fourth joint is extremely minute. The basal joint bears three curved spines on its inner distal margin. The merus of the second maxilliped (Pl. LXXIV. fig. 7) is less than twice as long as wide; the anterior prominence measures about two-sevenths the total length of the joint.

In the first pair of pereopods the carpus and chela are of equal length; each is about two-thirds the length of the merus. In the second pair the palm is almost one and a half times as long as the dactylus, the whole chela being rather more than three-quarters the length of the carpus. The carpus of the third pair is four-fifths the length of the merus; the chela is exactly half the length of the carpus and the palm is not appreciably longer than the dactylus.

The sixth somite alone is dorsally carinate. All the abdominal sterna bear a blunt and inconspicuous median tubercle with the exception of the first, which carries a very strong sharply pointed spine in the same position. This character, which is equally definite in both sexes, will probably prove of considerable specific value: it does not seem to occur in any of the species described by Bouvier.

The apex of the telson is rounded and furnished with a series of long plumose setæ (eleven in one fairly perfect example). One specimen (Pl. LXXIV. fig. 11) bears a pair of stout spines as

each of the outer angles; in another only a single spine is found in this position.

The petasma (Pl. LXXV. fig. 4) is a comparatively simple structure and is remarkably small for such a large species. The thelycum (Pl. LXXV. fig. 5) bears some resemblance to that of *G. alicei*. The triangular plate between the bases of the third pair of pereopods is not traceable in one of the females examined.

This species occupies a somewhat primitive position in the genus *Gennadas*. It is readily distinguished from all forms hitherto described, by the use of the characters suggested by Bouvier, by the prominent spine on the first abdominal sternum, and by the extremely narrow apex of the antennal scale.

GENNADAS BOUVIERI\*, sp. n. (Plate LXXIV. figs. 1-4; Plate LXXV. figs. 6 & 7.)

St. 206. W. of Manila. 17° 54' N., 117° 14' E. Trawl. 2100 fathoms. One female, 28 mm.

St. 220. N. of New Guinea. 0° 42' S., 147° E. Trawl. 1100 fathoms. Two females, 26 and 28 mm.

The rostral crest (Pl. LXXIV. fig. 1) is of much the same form as in *G. parvus*; the apical and dorsal teeth are, however, rather less prominent and the inferior margin is not so decidedly convex. The carapace is dorsally carinate throughout its length. Both the antennary and infra-antennary angles are acute and strongly pronounced, and the branchiostegal spine is distinct though very small. The cervical and post-cervical grooves are very closely approximate dorsally, the distance between them is scarcely more than one-fifth the distance from the post-cervical groove to the hinder margin of the carapace.

The second joint of the antennular peduncle, measured dorsally, is about the same length as the ultimate joint. The antennal scale (Pl. LXXIV. fig. 2), which is rather narrower distally than in *G. parvus*, is a trifle less than three and a half times as long as wide. The outer margin terminates in a short spine which extends slightly beyond the apex of the lamella.

The ultimate joint of the mandibular palp (Pl. LXXIV. fig. 3) is rather shorter than the greatest width of the basal joint. In the second maxilla the anterior lobe of the internal lacinia is slightly constricted behind its apex and is rather narrower than the adjacent and similarly constricted lobe of the external lacinia. The anterior lobe of the latter lacinia is one and a half times the width of the posterior lobe. The endopod is produced to a narrow apex furnished with two terminal setae and four curved spines on the dorsal aspect. The endopod of the first maxillipede is about the same length as the exopod. The third joint is almost twice the length of the second; the fourth joint, though small, is rather more evident than in the preceding species. The basal joint bears three curved spines on its inner distal margin. The

\* Professor E. L. Bouvier.



merus of the second maxillipede (Pl. LXXIV. fig. 4) is not quite twice as long as wide; the anterior prominence is almost one-third the total length of the joint.

In the first pair of pereopods the carpus, which is slightly shorter than the chela, is three-fifths the length of the merus. In the second pair the dactylus is equal in length to the palm, the whole chela being a little shorter than the carpus. The merus of the third pair is very distinctly shorter than the carpus, the chela is rather more than half the length of the carpus, and the dactylus is almost as long as the palm.

The sternum of the first abdominal somite bears a large and stout median spine; on the succeeding somites this is reduced to a blunt tubercle. The sixth somite alone is dorsally carinate. The telson is squarely truncate apically and is furnished with five plumose setæ between the usual pair of stout lateral spines.

The three females differ slightly in regard to the thelycum. One example (Pl. LXXV. fig. 6) shows the dark yellow and toughly chitinated spermatophores partially inserted beneath the large rounded plate, lying between the third and fourth pairs of legs. A second specimen is as nearly as possible identical with this, but the spermatophores are wholly covered by the thelycal plate. In the third example, which shows no spermatophores, the posterior plate is much shorter than the other two (Pl. LXXV. fig. 7), but it is possible that this is due, at least in part, to the contracted condition of the specimen.

Attempts to remove the spermatophores proved unsuccessful, for their inner ends are very firmly fixed (probably cemented) in a pocket or spermatheca lying beneath the plate.

*Gennadas bouvieri* differs from all the other species in the 'Challenger' collection in the proportional lengths of the merus and carpus of the third pair of pereopods. It takes rank in the second section of Bouvier's synoptic table, along with *Gennadas talismani*, *G. tinayrei*, and *G. valens*. We have no precise information concerning the branchial formulæ of these three species, but from Smith's account \* it seems probable that *valens* is a true *Amalopenæus*.

GENNADAS SCUTATUS Bouvier. (Plate LXXV. fig. 2.)

*Gennadas scutatus*, Bouvier, Bull. Mus. Océanog. Monaco, no. 80, 1906, figs. 8 & 13, and Rés. Camp. Sci. Monaco, xxxiii. 1908, p. 42, pl. viii.

St. 267. N. Pacific. 9° 28' N., 150° 49' W. 2700 fathoms.

One male, 21 mm.

The ultimate joint of the mandibular palp is only a trifle shorter than the width of the basal joint. The third joint of the endopod of the second maxillipede is wider than in Bouvier's figure, and the fourth joint is much less prominent. With the

\* Rep. U. S. Fish Comm. for 1882 (1883), p. 402.

exception of these details the specimen agrees in every respect with the French author's account. The petasma (Pl. LXXV. fig. 2) is almost identical with the text-figure published in 1906.

The presence of podobranchs on the first three pairs of pereopods indicates that this form, like the four species already described, is a true *Gennadas*.

*AMALOPENÆUS ELEGANS* Smith.

St. 45. Off the mouth of the Delaware R. 38° 34' N., 72° 10' W.  
Trawl. 2500 fathoms. One male, 24 mm.

The solitary specimen, which is without trace of podobranchs on the first three pereopods, is in all respects typical of this well known Atlantic species.

Three of the specimens present in the collection have not been determined:—

St. 101. Off Sierra Leone (sub *G. parvus* Sp. Bate).

This specimen, which is partially devoured by a parasitic worm, is figured in the 'Challenger' Report. Its condition is so bad that any attempt at identification is out of the question.

St. 220. N. of New Guinea (sub *G. parvus* Sp. Bate).

A single female from the above station is easily recognized as distinct from the two *G. bouvieri* occurring in the same haul. It appears to represent an undescribed species, but it does not seem advisable to attempt a description without more abundant material.

St. ? Off Bermuda (sub *G. intermedius* Sp. Bate).

The petasma of this small specimen, which was caught at the surface, does not appear to have assumed its adult form.

The following list of references may be of value to future workers at this group. So far as I am aware, it comprises all species referred to *Gennadas* (*sensu lato*) which have not been noticed in the present paper or in Bouvier's memoir:—

*Gennadas carinatus* Smith. N.E. Atlantic and Arabian Sea.

Smith (sub *Benthescymus* ? *carinatus*), Rep. U.S. Fish Comm.  
for 1882 (1884), p. 396, pl. x. figs. 6 & 7.

Alcock & Anderson, Journ. As. Soc. Bengal, lxiii. 1894, p. 147.

Alcock, Desc. Cat. Indian Deep Sea Macrura, 1901, p. 46.

McGilchrist (*G. carinatus* ?), Ann. Mag. Nat. Hist., March  
1905, p. 236.

*Gennadas borealis* Rathbun. Aleutian Is.

Rathbun, Proc. U.S. Nat. Mus. xxiv. 1902, p. 887.

Rathbun, Harriman Alaska Exped. x. 1904, p. 147, figs.  
88 & 89.

*Gennadas propinquus* Rathbun. Hawaiian Is.

Rathbun, Bull. U.S. Fish Comm. for 1903 (1906), p. 907,  
fig. 61.

*Gennadas* sp.

Ecuador.

Faxon, Mem. Mus. Comp. Zool. Harvard, xviii. 1895, p. 207.

*Gennadas* sp.

Hawaiian Is.

Rathbun, Bull. U.S. Fish Comm. for 1903 (1906), p. 907, fig. 62.

It is much to be regretted that so little is known concerning the branchial formulæ of many of the species. At present only one undoubted species of *Amalopenæus* is known—*A. elegans* Smith, though it is probable that the form described by Smith as *valens* also belongs to the same genus. Six species, viz., the four described in this paper along with *G. scutatus* Bouvier and *G. carinatus* Smith belong to *Gennadas* (*sensu stricto*). In all the remaining species precise information concerning the branchial formula is lacking. Even those who are not disposed to admit the existence of two distinct genera will recognize the value of the character for splitting the group into workable sections.

## EXPLANATION OF THE PLATES.

## PLATE LXXIII.

*Gennadas parvus* Sp. Bate.Fig. 1. Lateral view of the anterior part of the type specimen.  $\times 10$ .2. Apex of the endopod of the second maxilla.  $\times 65$ .3. Second maxillipede.  $\times 11\frac{1}{2}$ .4. Antennal scale.  $\times 11$ .5. Mandibular palp.  $\times 24$ .6. Apex of telson.  $\times 26$ .*Gennadas intermedius* Sp. Bate.Fig. 7. Lateral view of the anterior part of the type specimen.  $\times 6$ .8. Mandibular palp.  $\times 5\frac{1}{2}$ .9. Apex of the endopod of the second maxilla of the type specimen.  $\times 30$ .10. Apex of the endopod of the second maxilla of the second specimen.  $\times 30$ .11. Part of the endopod of the second maxillipede.  $\times 5\frac{1}{2}$ .12. Apex of the telson.  $\times 26$ .

## PLATE LXXIV.

*Gennadas bouvieri*, sp. n.Fig. 1. Lateral view of the anterior part of the carapace.  $\times 7\frac{1}{2}$ .2. Antennal scale.  $\times 8\frac{1}{2}$ .3. Mandibular palp.  $\times 10\frac{1}{2}$ .4. Second maxillipede.  $\times 14$ .*Gennadas calmani*, sp. n.Fig. 5. Lateral view of the anterior part of the carapace.  $\times 5\frac{1}{2}$ .6. Part of the second pereopod, showing the epipod, podobranch, and two arthrobranchs *in situ*.  $\times 9$ .7. Part of endopod of second maxillipede.  $\times 6$ .8. Second maxilla.  $\times 6\frac{1}{2}$ .9. Antennal scale.  $\times 4$ .10. Mandibular palp.  $\times 7$ .11. Apex of the telson.  $\times 21\frac{1}{2}$ .

## PLATE LXXV.

*Gennadas parvus* Sp. Bate.Fig. 1. Petasma, right side.  $\times 17$ .*Gennadas scutatus* Bouvier.Fig. 2. Petasma, left side.  $\times 25$ .*Gennadas intermedius* Sp. Bate.Fig. 3. Petasma, right side.  $\times 16$ .*Gennadas calmani*, sp. n.Fig. 4. Petasma, left side.  $\times 19$ .5. Thelycum.  $\times 7\frac{1}{2}$ .*Gennadas bouvieri*, sp. n.Fig. 6. Thelycum, showing spermatophores *in situ*.  $\times 20$ .7. Thelycum of another specimen.  $\times 20$ .

6. Notes on a Young Walrus (*Odobænus rosmarus*) recently living in the Society's Gardens. By P. CHALMERS MITCHELL, M.A., D.Sc., Hon. LL.D., F.R.S., Secretary to the Society.

[Received June 11, 1909.]

(Plate LXXVI. \*)

The Society received on Nov. 23, 1908, two young examples of the Atlantic Walrus, *Odobænus rosmarus*. The animals came from Franz Josef Land and were cubs born in the spring of the same year, and probably, therefore, under nine months old. It was stated that whilst the whaling ship, which brought them from the Arctic region, was in harbour, the animals were allowed to go to the bottom, ropes being tied round their shoulders to prevent their escape, and the sailors were of the opinion that they fed themselves there although they had no views as to what the food was. On the other hand, they had been fed on the voyage until their arrival in England, on whale's blubber. On their arrival at the Gardens, the only food that they would take at first, and which afterwards they appeared to prefer, was horses' fat. They took this from the hand in small pieces, and as they sucked it in, made a slobbering sound with their protruded lips. Whatever food they took, either from the hand, or from the ground, or from a bucket mixed with salt and water, they always sucked in small pieces, and would take only when it was soft and slippery. As fat is not a sufficient diet, every effort was made to get them to take something more nutritious. After a good deal of persuasion they were induced to take fresh fish, cleared of bones and cut into strips; they preferred cod to haddock or whiting, and would not touch filleted herring. They ate greedily the soft viscera of cod, such as liver and roe, and portions of the intestines. They also took mussels and scallops removed

\* For explanation of the Plate see p. 732.





*From a water-colour by Carlton Moore-Park.*

*Bemrose, Derby.*

YOUNG WALRUS (ODOBÆENUS ROSMARUS).



from the shells, but showed no knowledge of how to extract them for themselves, although they would bring up mussels from the bottom of their pond. They also ate slices of squid readily, but, although they would turn them over as if hunting for something, they would not eat edible seaweed, green laver (*Ulva*), ordinary seaweed (*Fucus vesiculosa*), or laminaria.

Walruses have been stated by Malmgren to subsist for two years almost solely on the milk of the mother, but it seems probable from the way these young animals would suck up soft food from the hand or seek it out when it was placed on the ground, that in the natural condition they subsist partly on chewed food accidentally or designedly dropped from the mouth of the mother\*. Whether their diet in the Society's Gardens was natural or not, it was evidently sufficient. One of the two specimens died as the result of a most unfortunate accident after it had been with us for about a week, and the other died of a severe double-pneumonia after a few weeks, but in each case the body was thoroughly well-nourished.

These young Walruses were extremely docile and intelligent. They made friends with the keeper very quickly and would follow him about, and would readily come out of the water to be fondled by anyone who took an interest in them. On one occasion a Sea-Lion, by a remarkable feat of agility climbed the barrier and came into the small portion of the pond occupied by the surviving Walrus. In the morning, the two animals were found peacefully sharing the sleeping-den. But the sea-lion had bitten the Walrus, although not seriously, and for a day or two afterwards no persuasion would induce the Walrus to leave its den and go out where it could hear and see the Sea-Lions.

It has been suggested that the pads of strong pellucid bristles, which form the drooping, whisker-like masses depending from the upper lip on either side of the nostrils, may serve as a kind of strainer. However this may be, they certainly must serve to protect the muzzle from injury. The young Walruses constantly rubbed their muzzles over the surface of the ground or against the sides and bottom of the tank. In moving on land, they not infrequently used the muzzle in progression, raising themselves partly from the ground with a considerable portion of their weight resting on these bristly pads. Moreover, in the rather laborious task of climbing out of the water on to the rocky edge of the pond, they almost invariably raised the head out of the water, pressing these bristles flat against the rock, and so to speak heaving themselves up as if with the aid of the fore-flippers they were on the way to stand on their heads. The rough bristles not only protected their muzzles but gave them a better hold on a slippery surface.

\* [Since reading the above paper I have been informed by Mr. B. C. Johannesen, who has frequently been to Franz Josef Land and who has watched Walruses in their natural state, that the young stay with the mother for about three years, and that they are fed on food which she chews and throws on the ground. He added that mussels and other shell-fish are the staple food.]

My friend and predecessor Dr. P. L. Sclater having called my attention to the want of a good figure of the young Walrus, taken from a living specimen, I was fortunate enough to enlist the interest of Mr. Carton Moore Park, F.Z.S., who made a series of careful studies from the living animal, one of these being reproduced in Plate LXXVI. The figure shows the animal in a characteristic attitude. The general coloration is a dull rusty black approaching to mahogany over the body generally, and with a strongly marked bluish tint on the naked parts of the face and flippers. The hair of the fur was nearly bluish black when dry. The eyes were brown and very soft and intelligent. The whiskers were translucent, and varied in colour from white or yellow to light-blue according to the incidence of the light falling on them.

#### EXPLANATION OF PLATE LXXVI.

Young Walrus, *Odobenus rosmarus*, drawn from a living example by Mr. Carton Moore Park, F.Z.S.

#### 7. Notes on the Viscera of a Walrus (*Odobenus rosmarus*).

By R. H. BURNE, M.A., F.Z.S.

[Received May 24, 1909.]

(Text-figures 231-234.)

Through the kindness of Mr. Beddard, some of the viscera of the young female Walrus, lately living in the Society's Gardens, were sent to the College of Surgeons for use in the Museum. Several preparations were made from them by the Prosector (William Pearson), and although the anatomy of the Walrus is fairly well known, particularly from the researches of Dr. Murie published in the Transactions of this Society for 1872, some few points worthy of record are shown by these new specimens.

#### *The diaphragmatic sphincter of the vena cava inferior.*

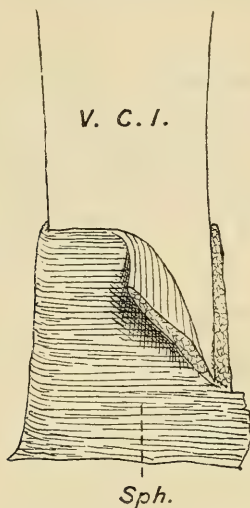
Among the viscera supplied to the Museum were the heart and lungs, and in connection with them the upper part of the vena cava inferior and a minute fragment of the diaphragm. In making this preparation the Prosector observed that the lower 3 cm. of the thoracic segment of the vena cava inferior was surrounded by a sheath of circularly disposed striated muscle directly continuous with the muscles of the diaphragm (text-fig. 231). The sheath is from 1-2 mm. thick and terminates towards the heart in a sharp, well-defined edge. For some distance from this edge it could easily be freed from the underlying wall of the cava, but was more firmly adherent to it near the diaphragm. A similar muscle has been described in *Phoca vitulina* and *Phocæna communis*\*, and apparently forms part of a mechanism for controlling the blood-stream in aquatic mammals.

\* Weber, Arch. f. Anat. (Müller) 1840, p. 236.



In Cetacea and Pinnipedes the vena cava and hepatic veins combine to form an enormous reservoir between the liver and the diaphragm (Barkow, "Die Blutgefäße") in which an immense quantity of blood can be stored. The exit from this reservoir is comparatively narrow and can obviously be still further decreased or possibly completely closed by such a sphincter band as that described above.

Text-fig. 231.



The thoracic vena cava inferior of a Walrus, showing the diaphragmatic sphincter band, *Sph.*

There seems little reason to doubt that the venous reservoir and the sphincter of the vena cava form parts of one mechanism, the use of which is possibly to restrict the flow of venous blood to the heart and so to keep up the average purity of the blood when the animal is immersed. For it is clear that the more the aeration of the blood is confined to that necessary for the action of the central nervous system and the voluntary parts of the animal, the further the oxygen stored in the lungs will go in carrying on the absolutely necessary activities of the body and the longer the animal will be able to stay immersed. It would thus seem to be of decided advantage to a diving mammal to be able to prevent, temporarily, the blood returning from the alimentary canal and liver (which forms a very great part of the blood carried by the vena cava inferior) from reaching the heart and lungs, for if this mass of impure blood were poured into the lungs, as in the ordinary course of circulation, it would tend to very greatly hasten the general fouling of the blood.

But during immersion the action of the vegetative as opposed

to the voluntary organs might without much disadvantage be held more or less in abeyance, and their circulation be stopped or retarded for the time. As a matter of fact the visceral circulation, even if the venous sphincter were completely closed, would probably not become quite stagnant, at least for some considerable time, for the returning venous current would be accommodated in the sub-diaphragmatic sinus. When the animal returns to the surface and breathes again, the temporary block on the vena cava inferior would be removed and the normal circulation restored.

In this connection it should be noticed that in the Walrus (Murie, *l. c.* p. 431) the arteries for the head and fore part of the body and for the alimentary canal are remarkably large in comparison with those for the hind limbs, so that evidently the two most important venous return currents are from the viscera by the inferior cava and from the fore part of the animal by the superior cava, that from the hind end of the body being insignificant. The removal of one of these chief sources of impurity from the circulation would necessarily greatly enhance the effective purification of the other.

Although this may be, and I think is, the primary function of this muscle, there is also the probability, as pointed out to me by my cousin (Mr. T. W. Burne), that the temporary closure of the vena cava inferior would help to relieve the pressure in the right heart consequent on the suspension of respiratory movements.

This pressure must be very great in diving creatures, and the paramount importance of its reduction is shown by the presence even in animals not aquatic, including man, of a well-known mechanism in connection with the tricuspid valve designed to act as a safety-valve and allow of the backflow of blood into the veins when the right ventricle becomes unduly distended through cessation of active respiration or by an increased flow of venous blood to the heart. This mechanism was exhaustively described many years ago by Mr. T. W. King\* (for the knowledge of whose paper I am much indebted to Dr. James Mackenzie), and his arguments, as he himself emphasizes, apply with added force to diving air-breathing creatures, for not only is the pulmonary circulation checked by the cessation of the respiratory movements while the animal is still otherwise in full activity, but as has been shown by Mr. Houston† the great pressure of the surrounding water tends to drive the blood from the surface of the body and concentrate it upon the heart. To obviate this and to retard the return flow of the blood, there are in most if not all diving air-breathing animals (both birds and mammals) great sinuses in connection with the chief veins in which the blood may collect on its way to the heart and into which it may regurgitate through the imperfectly closed tricuspid when the over-distended right ventricle contracts. But except in the case of the inferior vena

\* King, Guy's Hospital Reports, vol. ii. 1837, pp. 104-178.

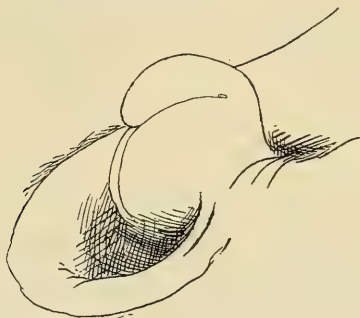
† Houston, Brit. Assoc. Reports, 1836, p. 81.

cava in Pinnipedes and Porpoises there is, so far as I know, no sphincter for cutting off the venous reservoirs from the heart, and in fact if there were, it would to some extent diminish their efficiency as receptacles to receive the backflow thrown into the veins through the tricuspid and auricle. One is therefore led to suppose that the function of the sphincter is primarily not so much to relieve the pressure on the heart, as by restricting the quantity of venous blood returning to the heart to prolong the time during which such blood as is absolutely necessary for the voluntary activities of the animal can be efficiently aerated.

*The generative organs.*

In the 'Journal of Anatomy' for 1900 (p. 159) Professor Cleland describes the reproductive organs of a young female Walrus and draws attention in particular to the condition of the cervix and corpus uteri—the part extending from the opening into the vagina to the point of separation of the two cornua. This part, except in those mammals in which the uteri are quite separate

Text-fig. 232.



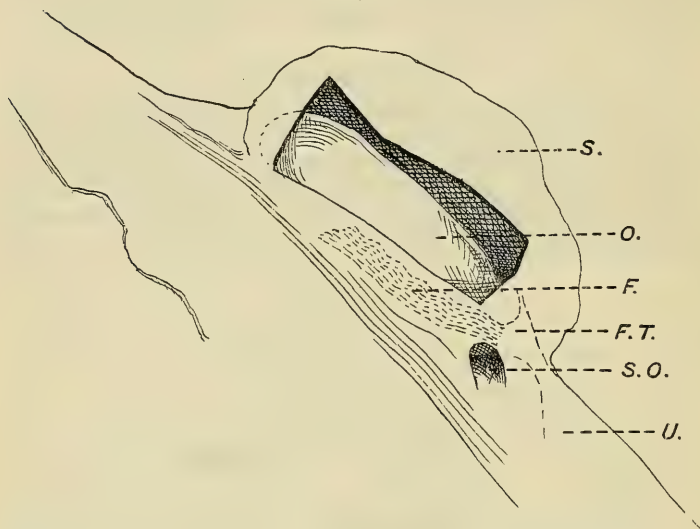
Clitoris and prepuce, seen from the side.

and open by distinct ora into the vagina, is normally a single or partly divided chamber opening below by a single os into the vagina and branching above into the two cornua. This, however, was not the condition found by Professor Cleland in his Walrus. On the contrary the cervix uteri was divided throughout its length into two distinct channels, lying side by side, separated by a thick median partition and opening into the vagina by separate ora situated upon a single swollen eminence. Distally each uterine chamber passed without interruption, except for a slight kinking of its rugæ, into the cornu of the same side. This exact condition is so seldom met with in mammals, although it occurs occasionally as a rare anomaly in man, that Prof. Cleland was doubtful whether he might not possibly have chanced upon an abnormal individual. This, however, seemed less likely, as he

found in *Otaria* and *Phoca* signs of a similar though less perfect subdivision of the cervix uteri. Nevertheless it seemed to him highly desirable that this point should be confirmed whenever the opportunity should arise.

The specimen now examined fully confirms Prof. Cleland's observation, so closely that any description of the uteri beyond the above abstract from his paper is unnecessary.

Text-fig. 233.



The ovary and ovarian sac of a Walrus, seen from the dorsal aspect, with the sac cut open.

*F.* Bundle of fimbriae running forward from the lower edge of the Fallopian tube, *F.T.* *O.* Ovary. *S.* Wall of ovarian sac. *S.O.* Opening of ovarian sac into body-cavity. *U.* Horn of the uterus.

Complete duplicity of the uterus combined with complete superficial fusion of the lower ends is recorded in some of the larger Bats\*, but I have not found a record of it elsewhere and there is no example showing such a condition in the large series preserved in the Museum†, although several Rodents with completely separate uteri suggest it. The next stage, in which the lower part of the uteri are completely fused to form a "body" separated more or less in its upper parts by a septum, but opening by a single os, is extremely common and naturally leads to the single chamber of the Primates.

This specimen also agrees with Prof. Cleland's in the large size of the urogenital sinus (6 cm. in length) and in its separation from the vagina by a strong hymeneal fold projecting from its

\* Robin, Ann. Sci. Nat. ser. 6, t. xii, p. 137.

† R. Coll. Surgeons.



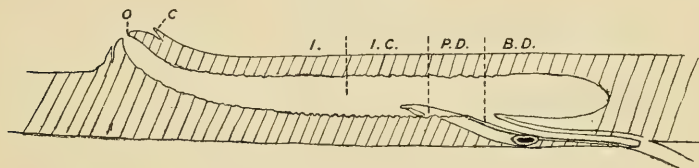
dorsal wall. The clitoris also is of great size, forming a large twisted prominence upon the ventral surface of the urogenital sinus and terminating in a swollen trifold glans that projects freely from the upper part of a deep preputial recess (text-fig. 232, p. 735).

The ovary, like that of the Seal and Sea-Lion, lies in a voluminous ovarian sac which communicates with the body-cavity by a small aperture upon the dorsal aspect opposite the uterine extremity of the ovary (text-fig. 233). The Fallopian tube is short and, so far as could be seen, straight, and opens into the ovarian sac by a crescentic aperture situated upon the roof of the ovarian sac just to the anterior side of its opening into the body-cavity. From the posterior lip of the Fallopian funnel a series of parallel ridges (fimbriæ) pass forward along the roof of the ovarian sac close to the line of attachment of the ovary. In the small size of the opening of the ovarian sac the Walrus more nearly resembles *Otaria* than *Phoca*.

*The bile and pancreatic ducts.*

Murie in his description of the bile duct and alimentary canal (*l. c.* p. 429) describes a curious and very extensive ( $5\frac{1}{2}$  in. long) dilatation of the common bile duct within the walls of the intestine between its point of contact with the gut wall and its

Text-fig. 234.



Bile and pancreatic ducts and their mode of entry into the intestinal cul-de-sac.

*B.D.* Bile duct. *C.* Fold encircling the papilla by which *I.C.*, the intestinal cul-de-sac, opens into the cavity of the intestine, *I.* *P.D.* Pancreatic duct.

communication with the intestinal cavity. The preparation made from this present individual in most respects fully bears out Murie's description, but to it should be added the mode of entry of the pancreatic duct; and I wish also, upon the suggestion of Prof. Keith, to put forward another interpretation of the nature of the dilatation of the bile duct within the intestinal wall.

The bile duct enters the intestine at a very acute angle close to the beginning of the duodenum. After running for 3 cm. without change within the substance of the wall, it opens suddenly by a well-defined circular aperture through the side wall of the elongated chamber described by Murie as the terminal part of the duct. This is not quite the same thing as "enlarging into

a capacious duct." The pancreatic duct enters the intestinal wall upon its concave aspect 1 cm. below the bile duct; it passes, within the substance of the wall, diagonally downwards towards the convex border of the gut superficial to the bile duct and opens into the elongated chamber upon a prominent papilla, just to the colic side of the opening of the bile duct.

The relative size of the elongated chamber and its coarse structure and appearance agree in every respect with Murie's description. It may be mentioned, however, that the papilla on which it opens is circumvallate, being surrounded by a sharp circular fold of mucous membrane.

Sections through the bile duct, elongated chamber, and intestine show that in minute structure the elongated chamber resembles the intestine rather than the bile duct; and there is little doubt, both on this ground and from the mode of entry into it of both the bile and pancreatic ducts, that this chamber is really a diverticulum of the intestine and not a dilated part of the bile duct.

The Sea-Lion, from Murie's description and figure\*, has a similar intra-mural bile receptacle; but I do not know of its occurrence elsewhere except in the Chelonia, especially *Dermochelys*, and, as I am told by Mr. Beddard, in the Edentate *Myrmecophaga*.

#### *The stomach.*

The curious U-shaped superficial appearance of the stomach has been already fully described, but at present there is no record of the histological structure.

Sections taken at three points, (1) close to the entry of the oesophagus, (2) in the middle of the U-shaped curve, (3) an inch from the pylorus, show that the histological structure agrees fairly well with that of the stomach of *Otaria*†. In localities 1 & 2 the submucosa was occupied by a number of peptic glands arranged in bundles separated from neighbouring bundles by connective tissue. In locality 1 the glands were only slightly more than half as long as in locality 2, but had very much the same structure, the parietal cells being very numerous in both. In locality 2 the deep ends of the gland tubes were inclined to be contorted. In locality 3 the glands were pyloric, and were large and much contorted, more so apparently than in either the Sea-Lion or the Seal. Their terminal parts formed a series of large lobules in the deeper parts of the submucosa, separated from each other by connective tissue, but near enough to one another to constitute an approximately continuous layer.

\* Murie, Trans. Zool. Soc. vol. viii. p. 565.

† Pilliet, C. R. Soc. Biol. ser. 10, t. i. 1894, p. 743.

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## NOTICE.

The 'Proceedings' for the year are issued in *four* parts, paged consecutively, so that the complete reference is now P. Z. S. 1909, p. . . . The Distribution is as follows:—

Papers read in January and February, issued in June.					
"	"	March and April,	"	"	August.
"	"	May and June,	"	"	October.
"	"	November and December,	"	"	April.

'Proceedings,' 1909, pp. 201-544, were published on August 23rd, 1909.

The Abstracts of the papers read at the Scientific Meetings in May and June are contained in this Part.



PROCEEDINGS  
OF THE  
GENERAL MEETINGS FOR SCIENTIFIC BUSINESS  
OF THE  
ZOOLOGICAL SOCIETY  
OF LONDON.

1909.

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PART IV. CONTAINING PAPERS READ IN  
NOVEMBER AND DECEMBER.

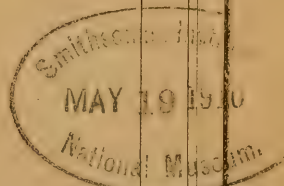
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November 9, 1909.

S. F. HARMER, Esq., M.A., Sc.D., F.R.S., Vice-President,  
in the Chair.

The Secretary read the following report on the additions made to the Society's Menagerie during the months of May, June, July, August, and September, 1909 :—

#### MAY.

The registered additions to the Society's Menagerie during the month of May were 201 in number. Of these 63 were acquired by presentation, 5 by purchase, 42 were received on deposit, 83 in exchange, and 8 were born in the Gardens.

The total number of departures during the month, by death and by removals, was 199.

Amongst the additions special attention may be called to the following :—

A pair of Sable Antelopes (*Hippotragus niger*), from South Africa, purchased on May 8th.

A male Chamois (*Rupicapra tragus*), born in the Menagerie on May 17th.

A Collection of Mammals and Birds from Venezuela, including a Brazilian Tree-Porcupine (*Coendu prehensilis*), a Green Hang-nest (*Ostinops viridis*), new to the Collection, and a Sun-Bittern (*Eurypyga helias*), presented by Albert Pam, Esq., F.Z.S., on May 19th.

A large Collection of Reptiles, including 3 Water-Vipers (*Ancistrodon piscivorus*), 2 Diamond Rattlesnakes (*Crotalus adamanteus*), 4 Texan Rattlesnakes (*Crotalus atrox*), 2 King Snakes (*Ophibolus getulus*), and 2 Say's Snakes (*Pituophis sayi*), received in exchange from the Zoological Society of New York on May 18th.

#### JUNE.

The registered additions to the Society's Menagerie during the month of June were 311 in number. Of these 75 were acquired by presentation, 159 by purchase, 37 were received on deposit, 23 in exchange, and 17 were born in the Gardens.

The total number of departures during the month, by death and by removals, was 144.

Amongst the additions special attention may be called to the following :—

1 Aard Wolf (*Proteles cristatus*), 1 Brindled Gnu (*Connochastes taurina*), and 1 Ground-Hornbill (*Buceros capensis*), from South Africa, received in exchange on June 7th.

1 Dziggetai (*Equus hemionus*) ♂, new to the Collection, from Mongolia, deposited by the President on June 10th.

2 Bantings (*Bos sondaicus*) ♂ ♀, from Further India, received in exchange on June 3rd.

1 Bhutan Takin (*Budorcas taxicolor whitei*) ♂, new to the Collection, from N.W. Bhutan, presented by J. C. White, Esq., C.M.Z.S., on June 22nd.

2 Ursine Tree-Kangaroos (*Dendrolagus ursinus*) ♂ ♀, new to the Collection, purchased on June 25th.

#### JULY.

The registered additions to the Society's Menagerie during the month of July were 123 in number. Of these 72 were acquired by presentation, 16 by purchase, 21 were received on deposit, 6 in exchange, and 8 were born in the Gardens.

The total number of departures during the month, by death and by removals, was 225.

Amongst the additions special attention may be called to the following:—

2 Crowned Duikers (*Cephalophus coronatus*), presented by Major H. F. Searight on July 1st; 2 Grecian Ibex (*Capra aegagrus*), presented by A. Trevor-Battye, Esq., F.Z.S., on July 17th; and 2 Baillon's Aracaris (*Andigena bailloni*), received in exchange on July 18th.

#### AUGUST.

The registered additions to the Society's Menagerie during the month of August were 226 in number. Of these 144 were acquired by presentation, 9 by purchase, 56 were received on deposit, 4 in exchange, and 13 were born in the Gardens.

The total number of departures during the month, by death and by removals, was 151.

Amongst the additions special attention may be called to the following:—

1 Siamang Gibbon (*Symphalangus syndactylus*), from Perak, presented by E. M. Hawes, Esq., F.Z.S., on Aug. 7th.

2 Bonteboks (*Damaliscus pygargus*), from Swellendam, Cape Colony, purchased on Aug. 5th.

1 Honduras Turkey (*Meleagris ocellata*), from Guatemala, deposited on Aug. 30th.

2 Goliath Herons (*Ardea goliath*), from Africa, presented by Frederick Burgoyne, Esq., F.Z.S., on Aug. 11th.

A large collection of Mammals and Birds, including 1 Great Ant-eater (*Myrmecophaga jubata*), 1 Capybara (*Hydrochaerus capybara*), 1 Hairy Tree-Porcupine (*Coendu prehensilis*), 1 Harpy Eagle (*Thrasaëtus harpyia*), 1 Helmeted Curassow (*Pauxis galeata*), and specimens of several species of Tanagers and other birds from Venezuela, presented by Albert Pam, Esq., F.Z.S., on Aug. 11th.

A Collection of Birds and Reptiles, including 3 Burrowing-Owls (*Speotyto hypogaea*), new to the Collection, 1 American Tantalus (*Tantalus loculator*), and 2 Terrific Rattlesnakes (*Crotalus terrificus*), new to the Collection, from Venezuela, presented by J. E. Aikman, Esq., C.M.Z.S., on Aug. 11th.

A large Collection of Birds, including 1 Great Black Cockatoo



(*Microglossus aterrimus*), 8 King Birds-of-Paradise (*Cicinnurus regius*), 2 Greater Birds-of-Paradise (*Paradisaea apoda*), and 5 Black Manucodes (*Manucodia atra*), new to the Collection, from the Aru Islands, deposited on Aug. 17th.

SEPTEMBER.

The registered additions to the Society's Menagerie during the month of September were 150 in number. Of these 101 were acquired by presentation, 27 by purchase, 7 were received on deposit, and 15 were born in the Gardens.

The total number of departures during the month, by death and by removals, was 161.

Amongst the additions special attention may be called to the following:—

1 Humboldt's Saki (*Pithecia monachus*), from Mañaos, purchased on Sept. 28th.

1 Maxwell's Duiker (*Cephalophus maxwelli*), from Portuguese Guinea, presented by Dr. W. J. Ansorge, F.Z.S., on Sept. 8th.

1 Sabre-horned Oryx (*Oryx algazel*), from the Sudan, presented by G. G. Chetwynd, Esq., F.Z.S., on Sept. 16th.

1 Monkey-eating Eagle (*Pithecophaga jefferyi*), from Luzon, purchased on Sept. 2nd.

1 Horned Tragopan (*Cerionis satyra*), from the Himalayas, presented by F. Naumann, Esq., on Sept. 9th.

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The Secretary, Dr. P. Chalmers Mitchell, F.R.S., exhibited the frontlet of a Mishmi Takin (*Budorcas taxicolor*), killed in 1903 in the country of the Mishmi tribe, N.E. of Saikwa, Upper Assam, and lent by Mr. J. D. Berrington, of Abergavenny. The frontlet was in very fine condition and was that of an adult, although the measurements were rather less than those of any specimens of the same species given in the fifth edition of Rowland Ward's 'Records of Big Game.' The formation of the horns conformed in every way with those of the typical Mishmi Takin as described by Mr. R. Lydekker in the Society's Proceedings (P. Z. S. 1908, p. 797).

The Secretary also exhibited a carved wooden figure of a Takin, presented to the Society by Mrs. Brian Hodgson, widow of Mr. B. H. Hodgson, who first named the Takin and made it known to science. The horns in the figure were well represented but the modelling of the body was inexact. The carving was made by the Khamti who killed the animals on which Mr. Hodgson described the genus, and is referred to in the original memoir (Journal Asiatic Soc. Bengal, 1850, p. 75).

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Professor E. A. Minchin, M.A., V.P.Z.S., exhibited two microscopic preparations of the *Cysticercus*-stage of a Cestode found by him in the body-cavity of rat-fleas (*Ceratophyllus fasciatus*), which he had dissected while investigating the problem of the

transmission of the rat-trypanosome (*Trypanosoma lewisi*). He stated that he had found no flagellate parasites in any rat-fleas which had not been fed on rats infected with *T. lewisi*, but had found incidentally various other parasites in the fleas in the course of his investigations, namely, a Protozoan parasite which infested the Malpighian tubes, another which was found in the heart and in the body-cavity, and lastly the Cysticerci which were exhibited. The Cysticerci were found free in the body-cavity and were of fairly common occurrence. In one flea three Cysticerci were found. They probably represented the larval stage of some species of tapeworm occurring in the rat. The fleas had been bred in special cages into which tame white rats were introduced to feed them. It was therefore certain that the fleas must have acquired them from the rats, probably in the young stages, by the flea-larvæ feeding on the faeces of the rat, and so ingesting the eggs of the tapeworm. It was proposed to institute some experiments in order to discover, by feeding young rats bred in captivity with food containing fleas, to what species of tapeworm these Cysticerci gave rise in the rat.

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*A new Nematode Worm from Trinidad\*.*

Dr. Robert T. Leiper, F.Z.S., Helminthologist to the London School of Tropical Medicine, exhibited specimens of

LAGOCHILASCARIS MINOR

(Leiper, Abstract P. Z. S. 1909, No. 74, pp. 35, 36),

a new Nematode causing abscesses in natives of Trinidad, which had been kindly given to him for investigation a considerable time ago by Dr. George C. Low, to whom they had been forwarded by Dr. Dickson, Medical Officer of Health, Trinidad.

The parasites occurred in the discharges of subcutaneous abscesses in two hospital patients, and were preserved in weak formalin. In this fluid they were white in colour, and resembled short pieces of thin twine. With the aid of a hand lens three well-developed lips could be seen guarding the mouth. Their presence is a sufficient indication that the specimens belonged to the family *Ascaridæ*, and rendered it probable that they were immature stages of the common *Ascaris* that had wandered into the connective tissues from the gut. This supposition proved incorrect, for in spite of their small size the worms were found on microscopical examination to be sexually mature. The females contained a large number of eggs. Moreover, the peculiar shape of the individual lips, and the presence of a narrow keel-like ridge of cuticle on either side of the body throughout its length, distinguished this form from the three species of *Ascaridæ* known to occur in man, viz. *Ascaris lumbricoides*, *Beluscaris mystax*, and *Toxascaris marginata*.

\* [The complete account of this new species appears here; but the name and a preliminary diagnosis were published in the 'Abstract,' No. 74 (Nov. 9, 1909).—EDITOR.]

*Description.*—The male worms are easily distinguished from the females by their smaller size—being 9 mm. in length by .4 mm. in breadth, as compared with 15 mm. in length by .5 mm. in breadth.

The posterior part of the body in the male is bent ventrally like a *pot-hook*—in the female it is straight.

The integument is marked transversely by fine striæ, there are no alæ at the anterior end of the body as in the species *mystax* and *marginata*, but the cuticle projects from the two lateral bands as a narrow ridge for almost the whole length of the body.

*Alimentary Canal.*—A deep furrow in the cuticle sharply defines the junction of the lips with the rest of the body. Each lip is separated from its neighbour by a short horn-like projection of cuticle, that arises from the floor of this groove. The cuticular covering of the individual lips is exceedingly strongly developed, and little can be seen of the pulp. Each lip is vertically split along its inner, or biting surface, giving that appearance of “hare-lip” which suggested the name *Lagochilascaris*.

The *Œsophagus* is a simple muscular bulb resembling that of other Ascaridæ, and measures in length in the male 1.1 mm., in the female 1.2 mm., its diameter increasing from .1 mm. to .15 mm.

The chyle intestine is a wide thin-walled tube ending in a short straight and chitinous rectum .15 mm. long.

*Genitalia.*—In the *male* the cloaca opens .13 mm. from the tip of the tail. The testicular tube is differentiated into three portions: (1) the ejaculatory duct about .8 mm. in length and attaining a greatest diameter of .13 mm. This gradually dilates to become (2) the seminal vesicle which extends forwards for a distance of 2 mm. and maintains through the greater part of its course a diameter of .2 mm., and terminates in (3) the testicular tubule which, with a diameter of .1 mm. or less, follows a much coiled course as far forward as the junction of the *œsophagus* and chyle intestine. There are two solid curved and colourless *spicules* measuring 3.5 mm. and 4 mm. in length. The pre-anal papillæ number over 24 pairs and there are apparently five pairs of post-anal papillæ, but these could not be ascertained satisfactorily.

The *female* measures 15 mm. in length. The vulva, guarded by slightly protruding lips, opens 6 mm. from the anterior end. The *vagina* passes forwards for a short distance, then turns backwards. The ovarian and uterine tubules occupy the middle third only of the body. The *ova* are round and pitted like those of *A. mystax*, thick-shelled and colourless, .065 mm. in diameter.

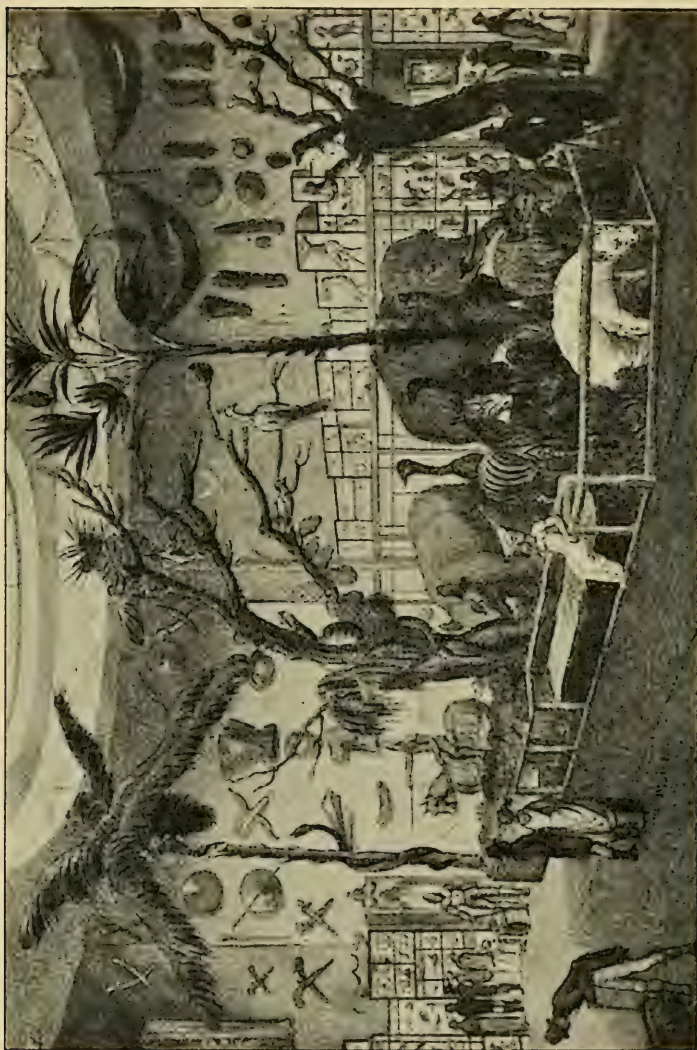
*Habitat.*—The alimentary canal is undoubtedly the normal habitat of this worm, and its occurrence in abscesses under the skin in the two cases from which it was obtained renders it likely that some other animal—probably one of the carnivora—and not man, is its normal host.

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On behalf of Mr. R. Lydekker, Dr. A. Smith Woodward, F.R.S., V.P.Z.S., exhibited an old coloured print (text-fig. 235) of the chief room of Bullock's Museum, in the building subsequently known

Text-fig. 235.



Bullock's Museum, 22 Piccadilly.

No. 18 of 'Ackerman's Repository of Arts, &c.,' vol. 3. pl. 35, 1810.

as the Egyptian Hall. The print was in an old scrap-book, formerly in the possession of Mr. Lydekker's family, and bore the printed legend "Bullock's Museum." Its authenticity is assured by the representation of the statue of the Black Prince,



which is one of the items mentioned in the catalogue of the sale of the collection, of which a copy is preserved in the British Museum (Nat. Hist.). William Bullock originally had a museum in Liverpool, but moved his collection to London about 1809, and apparently built the Egyptian Hall for its reception. The collection was sold by auction in London in the spring of 1819, when a number of specimens were purchased for the British Museum by Dr. Leach. Large extracts from the sale-catalogue are given in the second volume of the 'History of the Collections of the British Museum (Nat. Hist.)' The source of the plate, which was not known to the exhibitor, is indicated in the legend to the illustration.

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The following papers were read:—

1. Some Living Shells, their recent Biology and the Light they throw on the Latest Physical Changes in the Earth.—I. *Mya arenaria*. By Sir HENRY H. HOWORTH, K.C.I.E., D.C.L., F.R.S., F.Z.S.

[Received June 5, 1909.]

(Text-figures 236–243.)

In his paper on the proofs of a general rising of the land in certain parts of Sweden, published in the 'Philosophical Transactions' for 1835, p. 10, Lyell, in speaking of the living testacea of the Baltic, says:—"In regard to the shells I may observe that the *Mya arenaria* is the *only* one found by me in great abundance in any part of the Baltic which I did not see among the fossils of any of the localities already mentioned or those afterwards to be alluded to further to the North," *i. e.*, in the raised beds. This notable observation, then made for the first time, lay dormant for many years, and it was not until 1872, when engaged in exploring the coast of Skåne, the southern province of Sweden, that Nathorst remarked of an old raised beach situated 8 or 10 feet above the sea-level at Alnarp, near Malmö, in which the littoral shells, then living in the adjoining Sound, were found, that *Mya arenaria*, which is now common there as a living shell, did not occur, and he went on to suggest that it may have been a recent immigrant into the Baltic.

Nathorst's suggestion was presently confirmed in a remarkable manner by C. G. J. Petersen on Danish ground. In Rördam's memoir on the raised beaches of Zealand he in 1892 called attention to the fact that *Mya arenaria*, although such a toothsome mollusc, had never been found in the kitchen-middens of Denmark, nor in the raised beaches of the Isefiord, &c., which synchronize with them, and he concluded very reasonably that

the shell had in fact invaded the Baltic since the kitchen-midden men lived along the fiords of Denmark. Petersen's view is now generally accepted. It is possible, however, and important, to define more definitely the period when the shell first invaded the Baltic. It is first referred to by its recognised name in the tenth edition of the 'Systema Naturæ' of Linnæus, in which, however, he mentions that, in his work on his travels in West Sweden, he had already described it under the name *Concha arenaceo marino*. On turning to this reference, which has not been sufficiently appreciated, I find that he describes the shell at some length among the discoveries he made while at Oerost, an island in the district of Bohuslan, in West Gothland (see 'Wästgöta Resa,' 1747, p. 187). He adds that *he had never found it in any part of Sweden*, and clearly implies that he had not seen it until he went to Oerost. In his description of the discovery of the shell he tells us how, in searching the tide-washed sands at Oerost, he noticed a number of twin holes here and there unaccompanied by the little mounds of sand thrown up by burrowing worms, and, having put the stem of his long tobacco-pipe in some of them, was surprised to find it had struck against something hard. On burrowing with his hands he came upon the mollusc we call *Mya arenaria*, and that occasion was apparently the first time it had been noticed that molluscs in shells as well as freely moving worms dig holes of this kind. He goes on to say that the shell was found always buried under the sand-floors and never thrown upon the beach. This is confirmed by the habitat he gives the shell in his 'Fauna Suecica,' where he says of it: "*Habitat in Oceano Bohuslan alluente.*" As the visit of Linnæus to Oerost was made in 1747, when he was familiar with the zoology of Eastern Sweden, it amounts to a fairly complete proof that the shell was not living in the Baltic in 1747, and that it was only when he explored the coast of the Cattegat that he first found it.

Lyell, in the memoir already cited, and writing in 1835, goes on to say that it did not then live in the Bothnian Gulf as far as Södertelji, that he could not find it even at Calmar, while further south, at Sölvitzborg, it was rare and of very small size (*op. cit.* p. 10).

Kojenikof, writing in 1892, says that all the specimens he had found were young, by which he perhaps means they were dwarfed. He mentions its present distribution in the Baltic thus—Rügen, Stralsund, Greifswald, Stolpe, the Bay of Dantzic, Calmarsund, Gotland, near Memel, Libawa, Windawa, near Riga, Dago, Oesel, Hapsal, Matzalwick, Réval, near Narva, and the Bothnian Gulf as far north as 62°35' N. This proves how widely and rapidly it had spread in the Baltic since its introduction, and how much at home it now is in brackish water.

Long ago Dr. J. E. Gray had already said of the species that it is often found so high up the rivers that the water in which it lives is brackish only during high tides, adding that it is found moreover with freshwater shells on the coasts of the Baltic, while all

the other species of the genus are found only where the water is quite salt (Phil. Trans. 1835, p. 309).

Although it can live where the salinity of the water is comparatively slight, and is found in brackish water in the inlets on our own coast where the marine molluscan fauna is poor, it shares the feature of all marine shells transported to less salty water in being dwarfed and having a thinner shell. Thus in proceeding eastwards in the Baltic, where the water gradually grows fresher, we find its normal length in the Harbour of Kiel to be 100 mm., in the Gulf of Finland 55·70, and in the Bothnian Gulf 36·5.

The fact that so far as is known it does not occur anywhere in the Baltic in a raised beach however slightly elevated, or in a subfossil condition, makes it plain that since its introduction, there has been no appreciable elevation of the coasts of the lands bordering that sea. This may be said with some confidence of the period since Lyell wrote his Bakerian lecture in 1835, *i. e.*, about seventy-five years ago when we know it was living in the Baltic.

We will now turn to the Danish waters. There the evidence is equally plain that the shell we are discussing has only arrived recently. In his memoir entitled "Kartbladet Skamlingsbanke," describing the district on each side of the Little Belt, published by the Geological Survey of Denmark in 1907, A. Jessen has a good deal to say about the shells found in the north-western part of the island of Funen at the entrance of the Belt. Among the shells there found he mentions especially *Mya arenaria* as occurring in two places in what the Scandinavians call *Cardium* deposit, or what we should call estuarine mud. These places are both situated in what was lately the upper part of the Gamborg Fiord, but which has been recently embanked and laid dry. The extreme recency of this deposit is shown by an excavation Jessen made in the soil and by the table he gives of the depths at which the various shells in it occurred. The *Mya* only occurs in the surface layer at from ·40 to ·75 of a metre in depth, and is not found at any lower horizon in this estuarine deposit. It is plain, therefore, that it has only arrived in the Little Belt quite lately.

The only other part of Denmark in which the shell has been found on dry land is in the extreme north of Jutland, on the shores of the Limfjord and in "Wendsyssel," north of that inlet.

In another Danish Survey memoir also written by Jessen, and dated 1905, describing the eastern part of the Limfjord and some of its islands, he publishes some interesting tables of distribution of the shells found in the most recent beds, which he classes in five series. In two of them, namely the raised oyster-beds, of which he describes 22, and in the lagoon deposits still in progress (*Lagunedannelser*), of which he describes 8, the *Mya* does not occur at all. Among a series of 20 beds which are found bordering fiords and sounds with a stagnant and sluggish water, one only, situated S.E. of Broust, contained *Mya arenaria*. *This deposit was at the sea-level.* At Vejlen, north of the island of

Gjol, and on the south coast of the island of Oeland, in two instances only out of twenty-nine citations of beds from the broader part of the fiord did the shell occur. *In both cases at the sea-level.* Lastly, at Korsholm, south of Normandshage, an island situated in the mouth of the Limfiord, where it opens into the Cattegat, and subject therefore to considerable wave-action, the *Mya* occurred in a beach now being formed from the sea-level up to 1.3 metre in height. This was the only case out of eleven similar deposits quoted where the *Mya* occurred.

It is plain that in all these four cases the deposit may really have taken place within a few years only, and that it has done so certainly since any alteration in the level of the land has taken place.

Turning from the Limfiord to Wendsyssel, we have a more notable occurrence of the shell and one showing how easy it is in these matters to be misled. This was also originally published by Jessen in 1899, in the first volume of the Records of the Danish Survey, Raekke 3, p. 279. He mentions finding the *Mya arenaria* south-east of Nabstjert, in the south of Wendsyssel, at a distance of 300 metres from the present sea-shore, and at a depth of 0.6 of a metre under the sea-level.

Professor Brögger seems to have attached rather more importance to this discovery as qualifying his views of the quite recent arrival of the shell in these seas than it deserved, for in the later memoir already quoted, and published in 1905, Jessen points out that in comparing the map of this district published by the General Staff in 1883 with other maps dating from 1785–1787, it becomes clear that the coast has greatly altered here by silting, and that in the course of 100 years it has advanced 300 metres at Aalback, north of Nabstjert, while the mouth of the river Jerup, south of Nabstjert, had advanced eastwards 600 metres (Jessen's Memoir on the geological map of Aalborg and Nibe, northern part, p. 158 note). This shows that all the discovery at Nabstjert proves is, that *Mya arenaria* was living on the northern coast of Jutland a century and a quarter ago, for the place where it is now found at 300 metres inland was then in fact on the shore.

The Danish evidence, therefore, is perfectly consistent with that of Sweden in regard to the fact that the *Mya arenaria*, which now so abounds in both areas, is quite a recent addition to their marine Mollusca, and has only lately entered the Baltic, the Cattegat, of which the Limfiord is a mere inlet, and the Belts.

Let us now turn to Norway. *Mya arenaria*, according to Sars, now occurs living on all the Norwegian coasts from the Christianiafiord to the North Cape. It has also been reported from the warmer part of the White Sea. Professor Brögger is strongly of opinion, however, that as in Sweden and Denmark so in Norway, the mollusc is a recent arrival, a conclusion he bases on its absence from the raised beaches. (Brögger, "Om de sen-glaciale og post-glaciale Nivåförändringar," Norges Geol. Unders., N. 31, p. 605.)

Sars, who in 1863 had claimed that it occurs in a raised beach in



the island of Oeland, afterwards in 1867 withdrew the statement, and in the first part of his 'Bidrag til Kundskaben om Norges Arktiske Fauna,' p. 92, he says: "*Derimod er den ikke hos os forefundet fossil i vor glacielle Formation, idet Angivelserne om dens Forekomst her, som mins Fader senere har oplyst, grunde sig paa en Forveksling med den i Form og Størelse meget lignende Lutraria elliptica Lamarck.*"

De Geer overlooked this correction when he cited Sars as an authority for the occurrence of the shell in shell-beds at Trondhjem. Gwyn Jeffreys was similarly misled when he claimed that it occurs in the beds of the "glacial formation" at Christiania 50-200 feet above the sea-level, quoting Sars, 'Norges geologiske Undersøgelse.'

It is true that in a posthumous MS. work of Professor Münster he quotes the shell from a shell-bed at Smedholm, near Brevik, but inasmuch as this bed is only 66 m. above the water-level, it would seem from the observations of Oyen at the neighbouring place called Davo, where the conditions are similar, that at Smedholm the *Mya arenaria* has recently been washed up by the tide and been mixed with shells from the other shell-beds. Brögger similarly explains the finding of the shell at the level of the sea at Vallö, where again it does not occur in the raised shell-beds, no more than it does in those in the shell-beds at Storeng, Tromö and Arendal (*op. cit.* pp. 606-607); so that it is clear that it does not occur in any of the true raised beaches of the Christianiafiord or the Langesundfiord, or in any place on those fiords where there is any evidence that the land has changed its level since its arrival. On this Brögger and his colleagues are quite agreed.

There only remains one other place in Norway where *Mya arenaria* has been stated to occur in a raised beach, and to which Professor Brögger attaches more importance. This is at Kadland, at the south-west point of Norway.

In a notice by H. Rasch of a journey he made thither in 1833, he mentions going from Mandal along the river to Kadland. He found on the western bank of the river, where it rises in a kind of precipice 24 feet high, that the upper 16 feet of this was a coarse sand containing no remains, under which lay a bed of vegetable leaves, etc., matted together, *inter alia* hazel, birch, aspen, etc. This bed was sharply defined above and below; the lowest 5 feet consisted of a bed of "leerblandet" sand, in the upper part of which were a few scattered shells, and in the lower, shells in great numbers, consisting of the ordinary mollusca living on the coast, ex. gr. *Ostrea edulis*, *Venus islandica*, *exoleta* and *litterata*, *Mya arenaria*, *truncata* and *arctica*, *Buccinum reticulatum* and *capillus*, *Turbo littoralis*, *Trochus cinereus*, *Turritella terebra* and *edule*. The river at this point was a rapid one. (Mag. f. Naturvidensk. etc. 1836, pp. 299 & 300.)

Keilhau, who visited the place in 1838, confirmed the description of Rasch, giving more details. He reported further that he had been told that when the tide in the sea was high there was a large indraft of salt-water up this river, so that it became

brackish as high as Kadland. (Nyt Mag. f. Nat. vol. i. (1838) p. 187.)

It is unfortunate that no one has visited and critically described this important section since 1838, for the facts as reported seem very hard to explain. That a peculiarly littoral mollusc like *Mya arenaria* should have lived with a number of others whose habitat was several feet under water seems incredible. It appears to me a great deal more likely that, like other cases before cited, the *Mya* was an adventitious stranger in the shell-bed, and either had come up from the sea with the intruding salt-water as above mentioned and got mixed with shells of an earlier date, or had been able to live at Kadland for a while during some period when the access of salt-water was more continuous. It seems further incredible, from what we know of the habits of the mollusc and its adaptability, that if it had reached the Skawe, in Norway, before the coast had risen several metres at that point, that it should not have occurred in other raised beaches somewhere in Scandinavia, and should not also have found its way into the Christianiafiord and thence into the Baltic until so lately, and I cannot square Brögger's statement on page 556 that at Kadland the *Mya* may date from the time of the upheaved shell-bed, with his statement on page 605 where he says: "*Også i Norge var Mya arenaria hidtil ikke anført fra postglacial forekomst.*" The only other explanation of this Kadland shell-bed is that it may be of a different age to the other raised beaches of Scandinavia, and may perhaps represent an earlier horizon than is represented by those shell-beds. Hereby hangs an important issue.

Professor Brögger is very emphatic about the *Mya arenaria* not occurring in any of the raised beds of Norway, perhaps with the single exception of Kadland, and, as we have seen, the same view is generally held in the North in regard to the raised beds of Sweden and Denmark, and, with one notable exception, this seems incontrovertible. That exception has been overlooked by the northern malacologists and geologists. It is that of the famous shell-beds at Uddevalla and Capellbacken. The evidence is very strong, if not conclusive, that it occurs in the Uddevalla beds, although Brögger does not mention it in his account of them (*op. cit.* pp. 312-322). Hisinger long ago quoted it as found there, together with *M. truncata* (see Anteckningar i Physik och Geognosie, 1831, v. p. 83). Gwyn Jeffreys, in his account of the Mollusca of these beds published in the Report of the British Association for 1863, in which he describes all the collections in the then accessible northern Museums and in private hands, and in which he enumerates 83 species, distinctly mentions *Mya arenaria*, which is numbered 20 on his list. Again, in the British Museum, there is a valve of a typical *Mya arenaria* with the critical hinge perfectly preserved which came from the Thuden collection, and is labelled Uddevalla. Lastly, so far back as 1747, Linnæus seems directly to imply that the shell was found in the same place. This evidence

appears to me nearly conclusive, and it would seem to require us either to revise the decision of Brögger and A. S. Jensen that the shell does not occur in the Scandinavian raised beaches at all or to put the Uddevalla shell-beds in a different category to all the other raised beaches in the North, with the possible exception of the Kadland bed, which is a quite possible solution.

In some papers I have lately published in the 'Geological Magazine' on the recent history of the Baltic, I have tried to bring together the conclusions of the Scandinavian geologists on the subject, with some additional views of my own. I will shortly condense their main conclusions. The Northern geologists have shown that the raised beds on the shores of the Baltic consist of two entirely different series, one containing marine shells and the other freshwater and land shells only.

The marine shells in these raised beds correspond to the present marine fauna of the Baltic, except only that they show a change in their range due, as is virtually certain, to the water of the sea having become increasingly fresh. The typical shells in these raised beds are two species of *Littorina*—*Littorina litorea* and *Littorina rudis*, both of them greatly dwarfed. Hence they are known as *Littorina* beds.

The freshwater beds, which immediately preceded them in time, are specially marked by the presence of *Ancylus fluviatilis*, and are hence called *Ancylus* beds.

The inevitable conclusion from the position and succession of these beds is that the Baltic was formerly a great inland freshwater lake (the *Ancylus* sea) and in course of time was converted into a brackish-water sea (the *Littorina* sea), which still subsists although less saline than it once was.

The accepted explanation of this change, a most reasonable and inevitable one, confirmed by much evidence, is that after the human period known as the Kitchen-midden period there was a breach made in the land-bridge connecting Southern Scania with Denmark and Denmark with Mecklenburg, by which the Sound and the two Belts were opened, and the salt water of the North Sea for the first time made its way into the previously fresh *Ancylus* lake, converting it into a brackish-water sea and supplying it with the marine fauna which now occupies it.

The northern archaeologists on very reasonable data have roughly calculated that the Kitchen-midden men lived some 8000 years ago. Whether more or less, it follows that every raised beach in the Baltic containing a marine or brackish-water fauna has been laid down since the above-named breach took place. In other words, the *Littorina* period in the history of the Baltic extends roughly from 8000 years ago down to our own time. This means that during the last 8000 years there have been great changes of level in the Baltic lands involving their upheaval, and the elevation of the highest of these shell-beds is a measure of the amount of this elevation. They show that the movement has not been continuous but differential, the highest recorded instance being at a height

of 330 feet above the sea at Hernösand ('Sounnar Kursernai,' Upsala, 1893, p. 16), whence the highest range gradually sinks northwards to 51 metres at Neder Kalix at the head of the Gulf of Bothnia (De Geer, G. F. i Stock. För. xii. p. 104). From Hernösand the maximum elevation similarly falls gradually as we proceed southward, until in Southern Scania it is not more than 2 or 3 metres. The amount of elevation is similarly differentiated when measured transversely, being highest in the upper country and sinking gradually as we proceed towards the coast on either side. It has been made out further that this movement extends westwards also, and that we can draw isobaric lines along various parallels of latitude, showing that the rise of the Baltic coast of Sweden was paralleled by a corresponding elevation on its western coast, where it is similarly marked by raised shell-beds. These shell-beds on the shores of the Cattegat correspond in time to, but differ generally in contents from, those of the Baltic, just as the Cattegat differs and has always differed from the Baltic in its salinity and consequently in its wealth of marine life.

The raised marine shell-beds of Western Sweden have been divided into two sections—one at a much lower level than the other and separated more or less by a blank interval. The contents of the lower beds correspond in the main to the living fauna of the Cattegat, while the upper beds are markedly different.

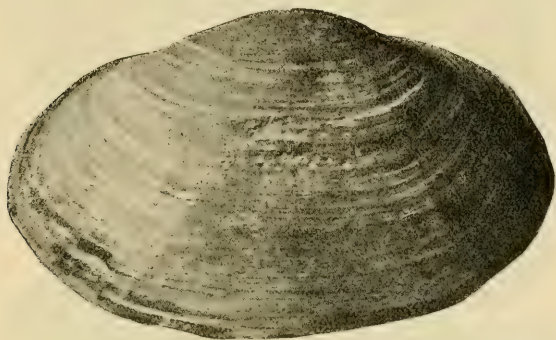
The famous beds at Uddevalla near Tröllhätten on the River Gotha, already referred to, apparently differ in an important respect from the other beds of similar elevation on the West Coast of Sweden. The peculiarity I refer to was first pointed out by G. Jeffreys, who in 1862 visited Uddevalla and collected 83 species of molluscs there. He showed that in these beds we have a curious collocation of molluscs from deep water with those from shallow water. What is most paradoxical about them, however, is the fact that the deep-sea shells lie over the shallow-water shells. This paradox was reasonably explained by Lyell by the suggestion that, previous to the deposition of the upper shell-stratum, there had been a depression of the ground by which the lower stratum or shallow-water stratum had been greatly depressed, the result being that the deeper-water mollusca invaded an area where the bottom was strewn with a dead fauna composed of shallow-water species. Afterwards both were uplifted together, the deep-water forms necessarily lying above the others, over whose old shells they had travelled when feeding.

It is a curious confirmation of such a movement having taken place, that in certain parts of the Cattegat two species of molluscs of a type which prevails specially at Uddevalla, each one being consequently qualified as *uddevallensis*, are found in dead and semi-fossilized specimens strewn over the floor of that fiord. These are *Mya truncata* var. *uddevallensis*, and *Saxicava rugosa* var. *uddevallensis*, both having been doubtless killed by the elevation of the sea-bottom which caused their brothers further east to be uplifted 200 feet.

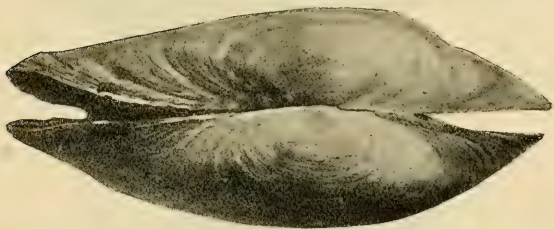


Here then we have a possible explanation of the problem we are seeking to solve, namely the presence of *Mya arenaria* at Uddevalla. It would seem that this very littoral shell belongs to the older and lower bed at Uddevalla, which consists of shallow-water and littoral shells, and that it was possibly exterminated in these northern waters by a sudden subsidence of their feeding-ground, which introduced conditions of much greater depth in the sea-bottom, or by some other similar revolution; and that the bed on which they lie represents a phase of the recent history of the marine fauna of Scandinavia not recorded in the books

Text-fig. 236.



Text-fig. 237.



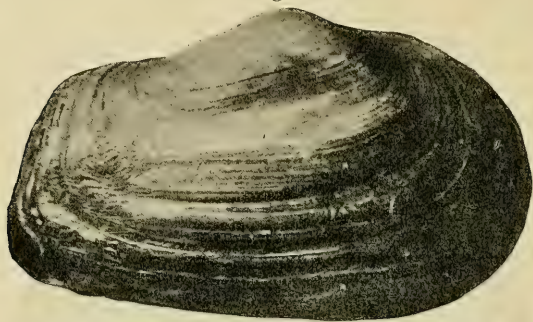
Lateral and dorsal views of shell of *Mya arenaria*; from Prof. W. C. Brögger's 'Om de sen-glaciale og postglaciale Nivåförändringar i Kristianfjeldet,' by kind permission of the author.

and perhaps older than some would credit. It seems to me, in fact, to represent the penultimate stage in the history of the submarine fauna in the Swedish and Norwegian waters, answering probably to the later Crag beds of England. It is possible that the bed at Kadland may represent the same horizon. In this way, and in this way only, can I explain the former presence at Uddevalla of a shell like *Mya arenaria*, which after having been extinct in these waters for at least 8000 years has now invaded them again and has rapidly occupied a much wider area.

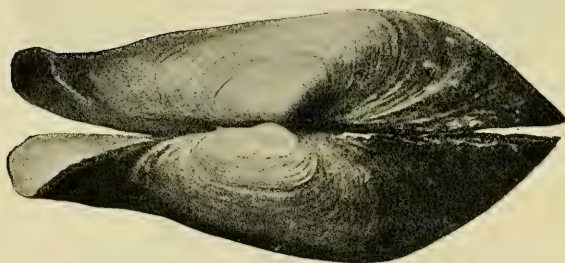
Suppose we accept this view as a tentative one, and proceed a

little further on our way and see how far the conclusion is borne out by other facts in the history of this remarkable shell. The question I would next ask is: Whence did *Mya arenaria* come

Text-fig. 238.

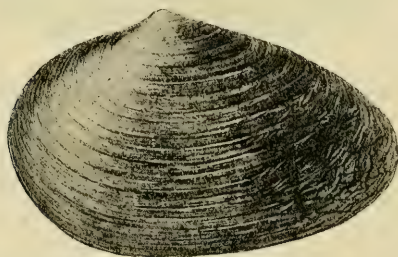


Text-fig. 239.



Lateral and dorsal views of shell of *Mya truncata*; from Prof. W. C. Brögger, *op. cit.*, by kind permission of the author.

Text-fig. 240.



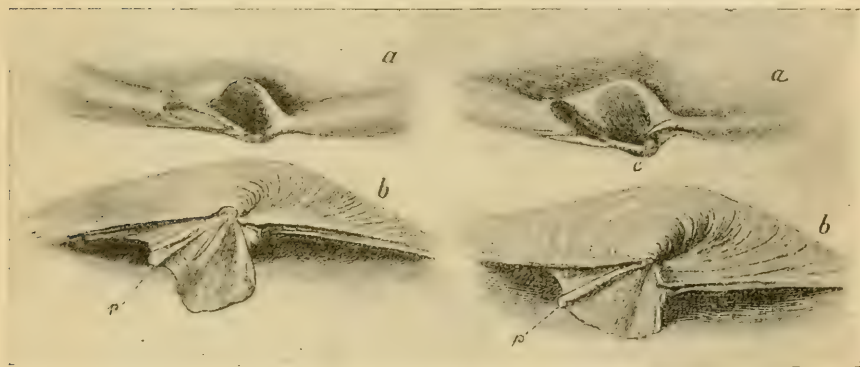
Lateral view of left shell of young *Mya truncata*; from A. S. Jensen, in 'Vidensk. Meddel. naturhist. Foren. i Kjöbenhavn,' 1900, by kind permission of the author.

when it invaded the Scandinavian seas? There are two species of *Mya* inhabiting the Scandinavian seas at present—*M. arenaria*

(text-figs. 236 & 237) and *M. truncata* (text-figs. 238 & 239). They differ very obviously in external contour. The former is an oval shell with its ends curved, one end being more obtuse than

Text-fig. 241.

Text-fig. 242.

Text-fig. 241.—Hinge of *Mya arenaria*.

*a*, right valve; *b*, left valve; *p*, tip of diagonal keel.

From A. S. Jensen, *op. cit.*, by kind permission of the author.

Text-fig. 242.—Hinge of *Mya truncata*.

*c*, locking-tooth; other letters as in text-fig. 241.

From A. S. Jensen, *op. cit.*, by kind permission of the author.

Text-fig. 243.

Hinge of *Mya truncata*, var. *ovata*.

Letters as in text-figs. 241 & 242.

From A. S. Jensen, *op. cit.*, by kind permission of the author.

the other, while the other species has one end (that through which the siphon of the mollusc is protruded and answering to the more pointed end of the other species) sharply cut off, whence

its name of *truncata*. This feature is exaggerated in a variety found in the Uddevalla shell-beds and known as *uddevallensis*, in which the shell is cut down to only half its normal size.

This truncation was apparently not a primitive feature of the species, for in young specimens it is hardly marked at all (text-fig. 240), nor is it present in the striations marking the stages of growth of the older shells in their earlier stages. Jensen was the first to point out clearly the important fact that the contours of the two species are really secondary and unimportant features compared with the character of their hinges, which he minutely describes. This can be better seen from the figures annexed (text-figs. 241-243), which he has kindly permitted me to reproduce from his epoch-making paper published in 1900 in the Vidensk. Meddel. naturhist. Foren. i Kjöbenhavn, p. 133.

Testing the specimens of *Myas* which are contained in the Northern Museums by this character of the hinge, he was able to show that all the *Myas* which from their oval outlines had been treated as *M. arenaria*, and which had come from Iceland, Greenland, Spitzbergen, Nova Scotia, the Kara Sea, and Siberia, are shown by their hinges to be really *Mya truncata* and not *M. arenaria*, and he accordingly gave them the name of *M. truncata*, var. *ovata*. This discovery, which has been fully accepted by Brögger and other unimpeachable judges, was very important, since it was on the evidence of these Arctic specimens that *M. arenaria* had been treated as a typically Arctic shell.

Not only so, but the alleged presence of *M. arenaria* in certain shell-beds in Britain had in many memoirs and books devoted to the cultivation of extreme glacial views been treated as a very special touchstone of glacial conditions. All this will now have to be revised as will the labels on many museum specimens. Jensen's emphatic statement, which I will quote in his own words, is conclusive:—"Resulttatet af den forudgaaende Undersøgelse kan i al Korthed udtrykkes saledes at *Mya arenaria* ikke er nogen højnordisk art" (*op. cit.* p. 149).

What is plain, therefore, is that *Mya arenaria* is in no sense an Arctic shell but only a boreal one, and that G. Jeffreys was quite mistaken when he made it so, and when he made the further inference, which has been copied into several geological works and is contained in the following sentence:—"The occurrence of this circumpolar shell-fish so near the tropic of Cancer probably indicates the most southern limit in space of the glacial epoch" ('British Conchology,' iii. pp. 65, 66).

It is further plain that when *Mya arenaria* recently invaded the Scandinavian waters it could not have come from the North. Did it then come from the South-west, from the British seas where it abounds, or from the coasts of Belgium and Northern France, where it occurs as far south as Rochelle? The fact that it does not occur further south in the Bay of Biscay and on the Lusitanian coast is curious. It is not less curious that its very recent history on the British coasts points to its having only



lately spread over the English seas. The first person to write on the English Mollusca in a scientific way was Dr. M. A. Lister, F.R.S., who in his book entitled 'Hist. Anim. Angliæ, etc.,' published in 1678, was the first to mention our shell, which he refers to as "*concha longa lataque*." He gives an excellent figure of the inside of one valve showing the distinctive hinge (plate iv. fig. 19), and tells us it was found in sandy ground near Philo (probably Filey in Yorkshire) and very abundantly at the mouth of the Tees (*op. cit.* pp. 170-171). In the series of plates of English shells dated 1687, entitled 'Hist. Conch.,' and apparently not published till 1770, he figures two varieties of the shell, one more ovate than the other (see nos. 262 and 263), and gives their habitat as "*Mar. Nor.*," by which he meant the North Sea, and it would appear that it was only as a North Sea shell that he knew it.

In his *Hist. Nat. Test. Brit.*, published in 1778, p. 232, Da Costa calls the shell *Chama arenaria*. He says of it: "The species is not common. I have received it from the Isle of Wight, near Newport, and from Hearne Bay, near Faversham, in Kent." This points clearly to the shell being then an uncommon one in the Channel. This is confirmed by the fact that it is not named by Pulteney in the first edition of his 'Catalogue of Birds, Shells, and Rare Plants of Dorsetshire,' published in 1799, but is mentioned and figured in that of 1813 in one of the notes, initialed "T. R." (*i. e.* Rev. Thomas Rackell), p. 28, where he speaks of it as found in Studland Bay, but says it is rare.

It would seem, therefore, that the shell had not been a long time in the Channel when these writers wrote at the end of the 18th century, and that there is a certain probability that it was in fact a newcomer to our seas. This is greatly strengthened when we examine the most recent deposits on our coasts.

It is almost certain that since the Christian era the land has been virtually quiescent in these realms. I know of no evidence to show that it has either risen or sunk during the last 2000 years. The coast has been eaten back in places, estuaries have been silted up and deltas enlarged, and there has been considerable alluvial accretion and growth of shingle-beaches, &c., in others; but in regard to any vertical change up or down, I know of no reliable evidence. All the evidence, on the contrary, points the other way and in favour of the level of the land having been stationary since the Christian era.

The only way, therefore, by which it might be possible to trace any changes in the fauna of the adjoining seas during the interval from the Christian era until to-day, would be an examination of the estuarine deposits and grey loams or buttery clay which have been deposited in such estuaries as the Wash and various inlets such as those on the coasts of Essex, Hampshire, &c., corresponding to the *Cardium* deposit in the now desiccated Gamburg Fiord above referred to. In regard to most of these inlets the available evidence is negative. The geological surveyors report no marine

mollusca from the marine alluvia of those portions of the Essex inlets which have silted up, except an occasional *Scrobicularia*. In their paper on the new dock excavation at Southampton in 1889, Messrs. Shore & Elwes give a list of the marine shells found in the estuarine mud there, which they say are similar to those of the numerous mud harbours on the south coast of Hampshire. The list includes 15 lamellibranchs and 23 gasteropods, but the *Mya* do not occur in it (Proc. Hants. Club, pp. 49, 50).

In the estuarine deposits at Rhyll the only shells found were *Scrobicularia piperata* and *Pholas candida* (see Survey Mem. Rhyll, &c., p. 41).

The evidence is the same from the marsh and fen deposits of Lincolnshire, from which *Scrobicularia piperata*, *Ostræa edulis*, *Cardium edule*, *Tellina solidula*, *Solen siliqua*, *Fusus antiquus*, *Purpura lapillus*, *Littorina litorea*, *Murex erinaceus*, and *Trochus cinerarius* have been forthcoming, but not *Mya arenaria* (see Memoir on the Map of East Lincolnshire, pp. 105–111).

The same is true of the estuary of the Humber, in the alluvium and warp of which we find *Scrobicularia piperata*, *Tellina solidula*, *Cardium edule*, *Littorina litorea*, and *Hydrobia*, but not *Mya arenaria* (Ussher & Reid, Memoir on Sheets 86, 185, and 189). The same is true again of the estuarine deposits in the Firth of Forth. More interesting because much more extensive are the similar Fen deposits round the Wash.

The Wash is clearly the shrunken remnant of what was formerly a great arm of the sea occupying the greater portion of the Fenlands, which has been gradually silting up for a long period by deposition of marine alluvium, and, as Skertchley showed, is in no way a delta deposit. In the now enclosed and desiccated parts of the primitive Wash, Skertchley divides the surface-deposits into what he calls Fen gravels and alluvium. He gives several sections of each, and in his list of the marine shells found in the Fen gravels the *Mya* does not occur. The alluvium he divides into two kinds—namely, clay and warp. In the clay he describes finding *Scrobicularia piperata*, many in single valves, but a fair average with both valves *in situ*; a few shells of *Tellina balthica* and dwarfed specimens of *Cardium edule*, *Mytilus edulis*, and *Ostræa edulis*; occasionally little Rissoas being plentiful. “I have never,” he adds, “found or seen a *Mya* or a *Solen*, although they are common enough in the Wash, neither does the *Cyprina islandica* occur, though it also lives in the Bay” (Survey Memoir on the Fenlands, p. 176).

On a later page, after giving a formal list of the fauna of the inland silts, he continues:—“The silt beds *forming on the shores* contain the same species, but with the addition of *Mya arenaria* and *Mya truncata*, both of which are common” (ibid. p. 182). This is surely a very interesting and notable fact, for this warp and marine alluvium of the Fens is the only deposit on a considerable scale in these realms where the latest history of

the English seas can be followed step by step and year by year; and it is a most eloquent fact that while *Mya arenaria* abounds in the present Wash, it does not occur, like the other shells from the same estuary, in the beds deposited in the immediately preceding period, and is very strong evidence of the recent addition of the mollusc to the fauna of the Eastern Coast.

This English evidence may be paralleled by that of Belgium. Thus Dr. Raeymaekers, who describes its common occurrence on the shores of the Low Countries, notably at Ostend, Heyst, and Blankenberg, speaks of it as a recent immigrant. "Malgré toutes nos recherches," he says, "nous n'avons pu découvrir *Mya arenaria* L. dans les dépôts supérieurs à la tourbe. Aucun des géologues qui ont publié des travaux concernant les terrains quaternaires d'Anvers n'a signalé la présence de cette espèce dans les formations modernes; celle-ci ne devait pas encore avoir apparu dans ces parages." He then describes a recent excavation made near Kruyschaus, not far from the redoubt of Oorderen, where he carefully studied all the layers above the turf (tourbe): "Malgré d'actives recherches, nous n'avons pu y trouver des exemplaires de *Mya arenaria* dans la tourbière encore ouverte; au nord au dessus de Doel, nous n'avons pas été plus heureux."

In the turf, he says, there are argillaceous sands, very damp and containing trunks of trees and shells of *Cardium edule*, *Scrobicularia piperata*, and *Tellina baltica*, and then the so-called Polder clay, but no traces of *Mya arenaria*, and he concludes: "Pour notre part, nous croyons que l'époque de l'apparition de *Mya arenaria* L. ainsi que la date de sa disparition du Bas Escaut sont relativement récentes et postérieures à la période espagnole."

Dr. Raeymaekers further showed that the sand covering the ditches at Lille rests on the Polder clay. These ditches he proved were made at the same time as the fortress of Lille, and could be emptied or filled at will by a series of sluices. The sand in question, a thin layer, contains shells of *Mya arenaria* so fresh that their epidermis is still preserved, as is the ligament uniting the valves of the *Cardium edule*. In the war of 1830 the Dutch opened the sluices and the country north of Antwerp was inundated. This continued till 1849-1850, when the Polders were again laid bare and cultivated, and it was during these twenty years that the Myas had invaded the ditches, thus explaining their being now found in dry ground and otherwise so fresh (Annales de la Société Malacologique de Belgique, xxx. pp. 5-11). The evidence, therefore, is very consistent and complete that they have only come to the shores of Belgium in recent times.

If we turn from these estuarine silts, the next deposits we come to are the raised beaches. Raised beaches do not, of course, occur on coasts which are being eaten back by the sea. We do not, therefore, find them on the east coast of England any more than on the western coast of Jutland. They do occur, however, in numerous places on the south and south-west coasts of this island, and afford good evidence that these coasts have not

materially altered in position since they were deposited, for although in the recessed portions of the various bays on the south coast the non-occurrence of raised beaches probably proves that their continuity has been broken at many places, yet their occurrence on the headlands shows that substantially the coastline remains where it was when they were laid down, while the raised beach on the Thatcher Rock in Torbay is another palpable evidence of the same fact.

As I have said above, there is at present no reliable evidence that the relative level of land and water on our shores has altered since the Christian era, and it would seem almost certain that all our true raised beaches—that is, those which represent old beach-surfaces and not mere deposits of pebbles and shells by high tides—are older than Roman times. They may be of different ages, but the persistence of one very notable raised beach at a level of 20 to 40 feet in Scotland seems to point to one particular upheaval having a wider range than could be caused by merely local causes, while the quiescence of the level since the Christian era seems to support the view that the upheaval was rapid and cataclysmic in Britain, as I have tried to show it was in Scandinavia.

The discovery of a number of dug-out boats of a very primitive type in connection with the raised beaches of the Clyde probably points to the relative date of the upheaval as having been in what is called the Neolithic age. A similar inference may perhaps be drawn from the finding of flint tools in connection with the raised beaches in the Isle of Man, in regard to which my friend Mr. Lamplugh writes:—"We gain a valuable clue to the approximate age of this beach in the presence of Neolithic chipped flints on its surface in places. The shingle seems to have been resorted to by the inhabitants for the sake of its pebbles of flint derived from the drift, which have sometimes been struck into flakes on the spot. . . . I found in the outer part of the beach a single artificial flake which had been partially worn down by marine attrition, and must therefore have been in existence as a flake during the accumulation of this portion of the beach. Between Rue Point and Blue Point I found these chips, in one place, in the blown sand covering the inner part of the old shore. These facts denote that at any rate part of the platform was in existence in Neolithic times, but that it may not have attained its full breadth until after the close of that period" (Survey Mem. Isle of Man, p. 403).

Let us now turn to the mollusca of the raised beaches. A monograph on the raised beaches of the southern coast was published by Prestwich in the Q. J. Geol. Soc. xlviii. p. 263. In this paper he gives several lists of shells found in them. In one case only does *Mya arenaria* occur, although the shell is such a common living shell in the Channel, namely on the Thatcher Rock in Torbay, which has a peculiar history and is probably much older than the other raised beaches of the Channel: Pengelly



thought it "pre-glacial"\*. It is surely singular that *Mya arenaria* should be absent from all these raised beaches in England save one, as it is from all the raised beaches of Scandinavia save one also, or perhaps two.

Let us now turn to another group of raised beaches and kitchen-middens, namely those in the south-west of Scotland. In his account of the kitchen-midden on the coast of Ayrshire known as the Ardrossan shell-mound, Mr. John Smith tells us that among the shells found in it the genus *Mya* was entirely absent. It is singular notwithstanding this that the most abundant living species at the present day in this district is *Mya arenaria*. In the lower estuary of the Gare Loch it was very abundant in muddy or gravelly sand twenty years ago, but has been almost exterminated for food by the people. (Trans. Geol. Soc. Glas. ix. p. 357.)

In the same writer's account of the whale-bed in Ayrshire he does not mention *Mya arenaria* as occurring either in the so-called glacial beds at Stevenston, Kilwinning, and Troon, or in the raised-beach beds at Shewalton Moor, while he says it is frequent on the present beach from Stevenston to Troon (*ibid.* x. p. 42). It is remarkable, he adds, that *Mya* has not turned up in the raised-beach beds, although one of the species (i. e. *truncata*) is common in the glacial beds and the other (i. e. *arenaria*) is frequent in the estuary of Gare Loch (*ibid.* p. 46).

The so-called Carse clays of the valley in which Stirling and Falkirk lie (which prolong the Firth of Forth westwards) and in which the skeletons of several whales have occurred, are probably of the same age as the lower raised beaches and kitchen-middens of the West Coast. Shell deposits occur in several places in these Carse beds. Thus, that at Cockmalane yielded *Tellina balthica* (var. *solidula*), *Mytilus edulis*, *Cardium edule*, *C. nodosum* (?) young specimen? *Buccinum undatum*, *Littorina litorea*, of large size, *L. rudis*, *Nucula nucleus*, *Trophon truncata*. Elsewhere oyster-beds occur, and also *Tapes pullastra*, *Macra subtruncata*, *Cardium echinatum*, *Trochus cinerarius*, *Purpura lapillus*, *Scrobicularia piperata*, *Rissoa ulvæ*, and *Fusus antiquus*. ("The old estuarine beds of the Carse of Stirling," Haswell, Trans. Edin. Geol. Soc. xi. p. 58.) Here it will be seen there is no mention whatever of *Mya arenaria*.

These facts make it almost certain that in the British seas, as in Scandinavia, *Mya arenaria* is quite a recent addition to the marine fauna. The fact that the shell has only quite recently been reported from the Italian seas points to its having also wandered very recently into the Mediterranean. These facts could not well have been known to Professor Brögger, who nevertheless, in trying to find the home from which the shell went to Scandinavia, suggests that it had come not from Britain, but from the Atlantic

\* On its occurrence on the Thatcher Rock, see Hunt, Trans. Devon Assoc. 1888' vol. xx. p. 227. The shells in the raised beach here were determined by G. Jeffreys' D. Pidgeon, and J. J. Marshall; among them is *Mya arenaria*.

coast of America, where it occurs as far south as Carolina and northwards to Labrador. Brögger classes it in fact with those other shells in the Christianiafiord which are also recent immigrants and have been very probably derived from America, e. g. *Acmea testudinalis*, *Lophyrus albus*, *Scalaria groenlandica*, *Cerithiopsis costulata*, and *Nucula delphinodonta* (Brögger, *op. cit.* p. 595 &c. and p. 712).

The history of *Mya arenaria* in America is a curious one. Its old home there is on the Atlantic coast of Canada and the United States, where it is a favourite edible mollusc, known as the Clam, but it has quite recently (about 1874) been transported to California to be fattened and has since spread rapidly in San Francisco Bay (see Stearns, *Mya arenaria* in San Francisco Bay, American Naturalist, xv. p. 362).

Let us, however, return to Europe, for we have not yet exhausted the interest of this shell.

While it seems plain that *Mya arenaria* is not found in any of the deposits in Europe later than the drift except in the currently deposited alluvium, there can be no doubt that it occurs, and occurs abundantly, in the Crag beds both in the Red or Suffolk Crag and in the Upper or Norwich Crag and its several divisions. It is quoted by Whitaker from the Red Crag at Beaumont (Mem. on Sheets 48 S.E. and 48 N.E. p. 30). It is also named from the Crag at Bulcham Pit, Dunwich Cliff, and Southwold (Geology of Southwold, p. 83), from the so-called Chillesden Beds at East Barent by Prestwich (Q. J. Geol. Soc. xxvii. p. 345), and from the so-called Weybourne Crag at Trimmingham, Sidestrand, Overstrand, Ranton, Sheringham, and Weybourne, and generally as very common by Mr. Clement Reid; and locally from the Norwich Crag at Burgh near Aylsham by Mr. Harmer, who in another place reports the shell as common in the Norwich Crag (Proc. Geol. Assoc., Later Tert. hist. of East Anglia, p. 466).

It is also reported from the shell-bed on the shore at Selsea (see R. Bell, Yorks. Phil. Soc. 1892). This bed is clearly older than the drift, that is to say, is what is generally called pre-glacial, since it underlies the famous gravel-bed which contains very large boulders. G. Jeffreys also quotes it from the Crag of Belgium.

In regard to the Chillesford beds there are some fine, perfect and very typical examples of the true *Mya arenaria* in the British Museum.

It is perfectly plain, therefore, that *Mya arenaria* was living in the British Seas in the period of the Red and Norwich Crag, as it is plain that it is an abundant shell on our coasts now, but that between these two periods it became extinct here and was reimported. This involves some interesting issues. The only marine beds lying between the Norwich Crag and the raised beaches are the drift or so-called glacial beds. What is the testimony of these beds on the question, and what is the exact meaning of that testimony? A very great change has come over geological opinion in regard to the fossil contents of the drift beds during the last thirty years. It was Searles Wood who first separated the so-called Middle Sands of Norfolk from the Crag.

Before him, these sands were treated as true Crag. The difficulty of separating them is in fact very considerable, and it must be allowed that the separation was made on most unsatisfactory grounds, and Mr. Whitaker quite admits in a letter to myself that much which was once thought to be drift has been shown to be Crag.

When Wood and Harmer separated the so-called Middle Sands of East Anglia from the Norwich Crag and its several subordinate divisions, the Weymouth Crag, Chillesford Crag, etc., they proceeded to constitute them a new biological horizon and to treat their molluscan contents as glacial shells. This view Wood subsequently somewhat modified. It was Mr. Horace Woodward who first threw a flood of light on the subject by his suggestion that the shell-fragments, &c., of the drift beds of Eastern England were in no sense at home there, and did not constitute a special biological horizon, but were in every case derivative. In his various papers and memoirs on the East Anglian drifts he has emphasized the point, and I have been indebted to him for much information on the subject.

In his paper on the Glacial Drifts of Norfolk he calls attention to the fact that the fragments of shells found in them represent more than a hundred species identified by Messrs. Wood and Harmer as Crag shells, a considerable number of them belonging to the Coralline Crag. It was this discovery, which seemed to point to warmer conditions, that first started the notion of warm inter-glacial periods interposed in the so-called glacial age. Mr. Woodward entirely disputed the cogency of this evidence. He said: "The aspect of the shells alone makes one sceptical, and it is admitted that they did not live on the spots where they have been accumulated." These beds, he says, "pass southward into gravels which underlie the chalky boulder-clay"; and he urges that the fragmentary shells in them have been largely derived from old Crag formations which were entirely destroyed or buried beneath the waters of the North Sea. Mr. Clement Reid, who once held a different opinion, wrote to me many years ago saying: "The fauna of the Middle Glacial sands of Norfolk, I now have no doubt, is entirely derivative," and proceeded to show very clearly that Searles Wood's theory about their contemporaneity would not hold water. See the whole subject discussed at greater length in my 'Glacial Nightmare,' p. 430; 'Ice and Water,' ii. pp. 104-106 and p. 206. If derivative, I cannot for a moment doubt that they were derived, as Gunn and the earlier Norfolk geologists urged, from the Crag beds, being merely redeposited Crag shells. Wood himself was constrained to admit that they were derived, but argued that they came from some other otherwise unknown glacial beds.

What is true of the East Anglian drifts is almost certainly true also of the drift of Lincolnshire, the shells in which are very fragmentary and rubbed: see Survey Memoir on East Lincolnshire, p. 91, for a long list and description of them; see also the

Memoir on Sheet 86, and pp. 177-183, where the mollusca in several pits are described, apparently in all cases very fragmentary and much broken, and in no case *in situ*.

The drift beds of East Yorkshire tell the same story. Mr. Lamplugh has conclusively shown that none of the shells in the shell-bed at Bridlington nor those found at Dimlington near Spurn Point had been obtained from beds "in place," but from "*masses of sand and clay occurring as boulders in the basement boulder-clay.*" That is, that the shells were transported. Dr. G. Jeffreys at the reading of the paper said he believed from personal inspection that this was a remanié deposit (Q. J. Geol. Soc. xl. p. 326). In his 'Geology of Holderness' Mr. Clement Reid fully admitted the fragmentary and transported character of the shell-beds, and Mr. Lamplugh again remarks on the inclusion in the so-called basement clay of stratified patches of transported sand containing shells. It is clear, therefore, that the Mollusca in the Yorkshire drifts, like those in the East Anglian ones, are derivative and so could only have been derived from the later Crag beds.

Again, Mr. E. T. Newton has expressed the opinion that the whole of the fish-remains at Bridlington are either Norwich Crag, Red Crag, or London Clay; and seeing that so many of the Crag Vertebrata have been originally derived from the London Clay, it is quite possible that all the Bridlington fishes have been derived directly from the Crag. He adds the very important sentence: "I should doubt if any of them were contemporaneous with the Bridlington deposits, and the mineral condition and polished surface of the specimens are characteristic of Crag fossils. This would seem to point to the destruction of older Tertiary beds during the formation of the gravelly sand containing the Arctic fauna." (Q. J. Geol. Soc. xl. p. 322.) Mr. C. Lewis says that the character of the shells in the Weybourne Crag accords well with that of the shells at Speeton.

Travelling further north, we find similar broken and much comminuted shells in the drift beds of Durham and Berwickshire whose condition similarly proves their derivative character. Further north again we find that in the drift beds of Eastern Scotland the shells are precisely in the same condition, comminuted, striated and smoothed, and very seldom whole. Professor Geikie describes them as scattered confusedly through the mass, like the boulders with which they are associated. This is especially the case with the shelly drift covering a large part of Caithness. Moreover, Peach and Horne found numbers of smoothed and striated shell-fragments in the Orkneys. This all points unmistakably to the shells in question being derivative and not *in situ* in the drift beds, and belonging in fact to an earlier horizon. I presume that most people who have seen them as they are found would in fact claim that they are older than the drifts in which they occur, or, to use the language of the glacialists, that they are pre-glacial. According to my view, the marine horizon



immediately preceding the drift was that of the so-called Norwich Crag. I hold, in fact, as I said previously, that there is no such thing as a biological horizon represented by the drift beds of Eastern England and Scotland; that, whether distributed by ice or water, all their biological contents are older than themselves and remanié. This is important in respect of the subject matter of the present paper, since Mr. Lamplugh mentions that *Mya arenaria* has been found in the lower Bridlington beds, although he has not verified the discovery himself.

In one instance I find *Mya* with a query cited from the drifts of Lincolnshire (see Survey Memoirs, Linc. p. 182). *Mya arenaria* has been repeatedly reported as discovered in the drift beds of Eastern England. Wood mentions it in 'The Crag Mollusca.' It is named from Corton by Mr. Harmer in his memoir on the country round Norwich, and by Mr. Blake from Gorleston Cliff in his account of the country round Yarmouth and Lowestoft. The comminuted and water-worn condition of the fragments (whole shells being very rare) makes it often uncertain about the identification of the species of *Mya*, since, as we have seen, it is only the hinge that is of importance. Mr. Blake, speaking of Gorleston, says: "Some of the loamy bands contained finely comminuted shell-fragments, whereas in other places fragments from an inch to more than two inches in length of such shells as *Cyprina islandica* and *Mya arenaria* were seen mixed with smaller fragments, all water-worn" (*op. cit.* p. 39). It is clear that in view of Dr. Jensen's discovery these fragments of *M. arenaria* should be re-examined. What is plain, however, is that, whether they be true *M. arenaria* or not, they have come from re-arranged Crag deposits and have nothing to tell us of any horizon subsequent to the Crag.

Let us now turn to the Irish Sea. It has always seemed to me strange that the writers on the Crag beds should have so entirely limited their investigations to the two sides of the southern part of the North Sea. For it is quite clear that Britain in the time of the Crag was washed by seas on the west as well as on the east as it is now. It startled some people greatly when Jamieson discovered true Crag deposits in Aberdeenshire as late as 1862, and when similar deposits were discovered at St. Erth in Cornwall. Now that we know that the fragmentary shells in the drift of Eastern England are all derived from Crag beds, the problem has become more interesting and important.

It is at least *a priori* probable that what is true of the fragmentary shells in the drifts of Eastern England and Scotland is true also of the broken shells of the drifts of Western England and Scotland, and it has been generally urged that these broken and rubbed shell-fragments are also derivative. Those who know them best are all of this opinion. In my 'Ice and Water' I have quoted Forbes, Meilard Read, Darbishire, Kendall, Crosskey, G. Jeffreys, and the British Association Committee on the beds of Kintyre, for the drifts of Macclesfield, Lancashire, the Isle of Man, Arran, and Kintyre (*op. cit.* ii. pp. 113-119). They are all

agreed on the subject that these fragmentary shells are transported, re-arranged and derived from earlier beds. Now the beds preceding the drift in Western England, just as in Eastern England, must have been deposited in the Crag-sea. The shells are no doubt not precisely the same on both sides of England, but the conditions were not quite the same either. It is exceedingly probable that Ireland and Scotland were united at some point during the Crag time, so that the shells in the southern part of the Irish Sea and those in the northern part would have been somewhat different, there being no access in the south to the northern indraft of cold water. This would not affect the contemporaneity of the shell-beds, however, on either side of the island any more than the present divergent fauna of the Baltic and the Cattegat do so.

While the contents of the *drift beds* show every sign of being derivative, this does not mean that all the later beds in the western parts of Great Britain are so. Just as there is every reason for thinking the shell-beds in Nairnshire to be *in situ* and to be, as I have urged elsewhere, older than the drift which overlies them (see *op. cit.* ii. p. 118), so also is it the case with the low-lying shell-beds in the Kyles of Bute and some other sites in Western Scotland. Mr. James Smith, of Jordan Hill, was the first to discriminate two sets of shell-beds in this district (see Smith, 'Newer Pliocene Geology,' p. 79). These seem certainly *in situ* and to be older also than the drift, and in my opinion they represent the later Crag of the West Sea just as the beds at Aberdeen represent the Crag of the North Sea.

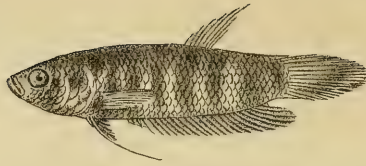
Here again our shell *Mya arenaria* comes to our assistance. Just as it abounds in the Norwich Crag so does it abound also in the Bute beds.

Two splendid valves of typical *Mya arenaria* from the shell-beds of the Kyles of Bute are in the British Museum from the Richmond Collection, and are labelled Glacial (see number 35020).

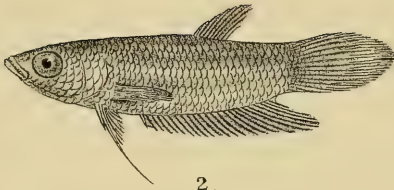
Crosskey and Robertson found the shell in the same place. They in fact presented some specimens of it from the Kyles of Bute to Professor Sars in 1866. Brögger describes them as of the typical form and they still preserve their original label, *Mya arenaria, glacial clays, Kyles of Bute*. To which Sars added in his own handwriting, "glacial" with a query. The shell is named from the same locality in the appendix to Sir A. Geikie's Memoir on the Glacial Drift of Scotland (Trans. Geol. Soc. Glas. i. pt. 2, p. 176).

Robertson and Crosskey also name a single valve of *Mya arenaria* as having been found in the Lochgilp beds (*ibid.* iii. p. 122). These several beds I deem to be what are generally called pre-glacial or, as I prefer to call them, late Crag; and it was from similar late Crag beds that the fragmentary shells in the Isle of Man and the Lancashire drifts were derived and among them the *Mya arenaria*, which is mentioned from the Isle of Man beds at Glen Wyllin by Mr. Kendall.

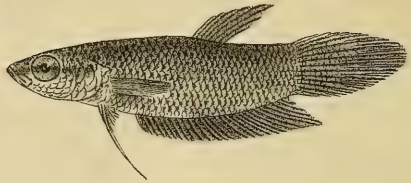




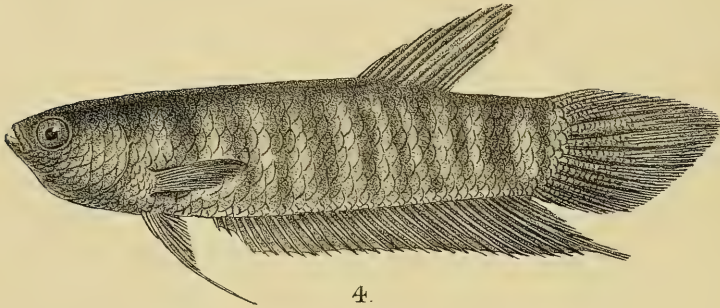
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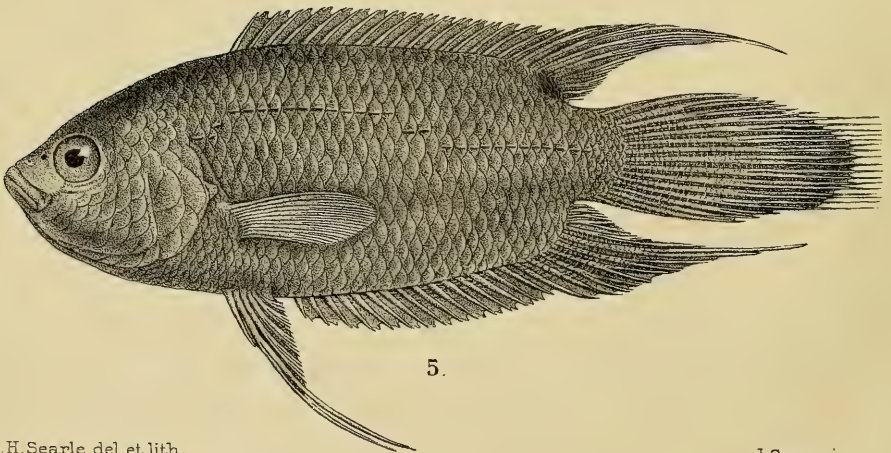
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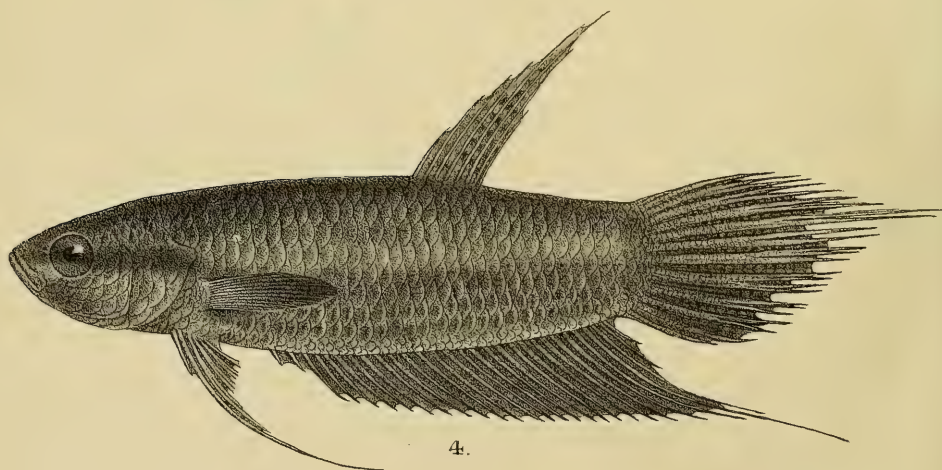
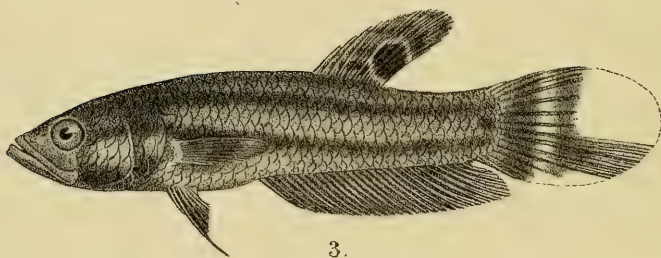
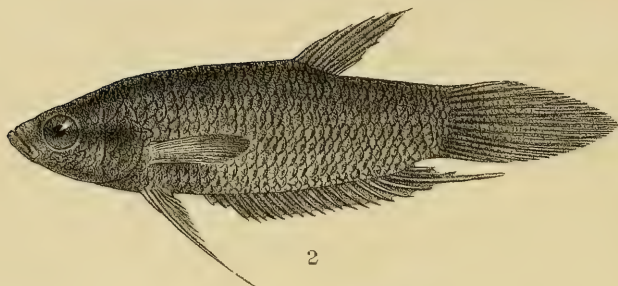
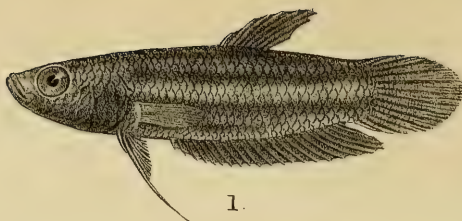
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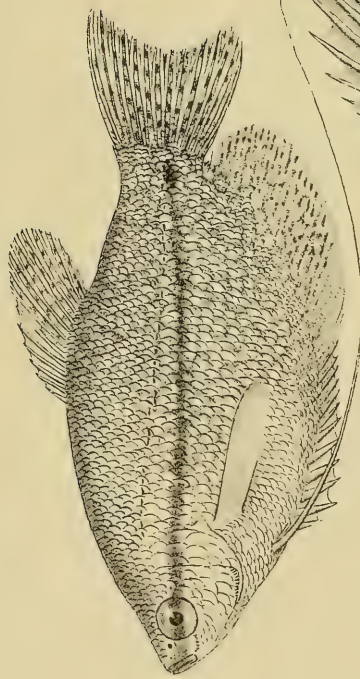


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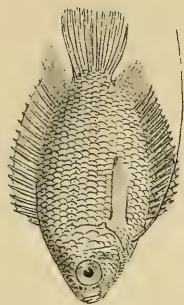
J.Green imp

1. BETTA TAENIATA. 2 B.FUSCA.  
3.B.MACROSTOMA. 4.B.ANABATOIDES.

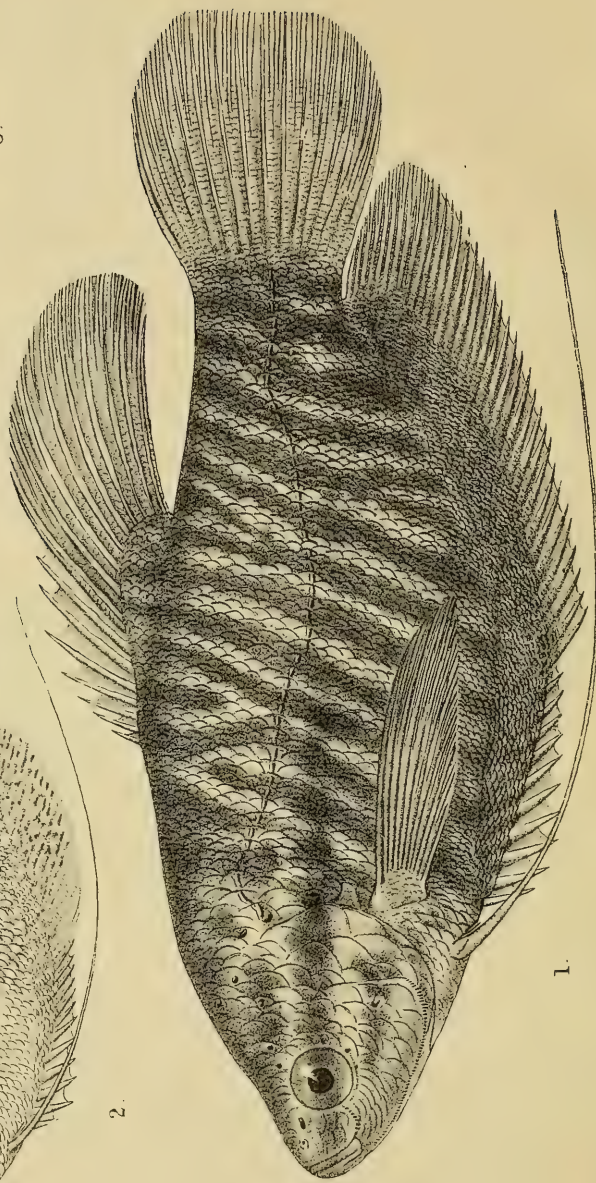




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To sum up shortly the result of this induction. It seems fairly proved that *Mya arenaria*, one of the very commonest shells in the present seas of Scandinavia, Britain, and Belgium, where the conditions are singularly favourable for it, has only recently invaded those shores. Secondly, that it is not an Arctic shell as has been supposed, but a boreal one. It has not been found living in Arctic waters, and its alleged occurrence there has been due to a mistaken inference. Hence, all deductions as to glacial climate deduced from its having occurred in certain beds must fall to the ground. It may well be, as Brögger suggests, that when it recently invaded the European seas it came from North America. On the other hand, the same shell existed abundantly in Britain in the times of the Middle and Later Crag, and has been found in Scandinavia at Uddevalla, affording some evidence that a portion at all events of the Uddevalla shell-beds are what is called pre-glacial or late Crag. So that the mollusc must have died out for a considerable time or been exterminated. Meanwhile it becomes a very good test to discriminate between the shells of the Crag and those derived from it, on the one hand, and the subsequent fauna of the raised beaches etc., down to recent times, on the other. The cause of its extinction and the explanation of its reintroduction, unless the latter was due to human agency, are equally puzzling. The notion that *Mya arenaria* was the victim of that *Deus ex machina*, the Ice Age, is excluded by the fact that the companions of this shell in our modern estuaries suffered no such extinction, but survived all through the period from the Crag age until our own day.

## 2. The Asiatic Fishes of the Family Anabantidæ.

By C. TATE REGAN, M.A., F.Z.S.\*

[Received September 27, 1909.]

(Plates LXXVII.–LXXIX.†)

In my classification of the Teleostean Fishes (Ann. Mag. N. H. (8) iii. 1909, pp. 75–86), the Anabantoidei are placed as a sub-order of the order Labyrinthici, which includes also the Ophiocephaloidei.

The Labyrinthici form a terminal group which has attained a considerable degree of specialization; they are physoclistic, the parietal bones are separated by the supraoccipital, there is no orbitosphenoid, the protractile præmaxillaries exclude the toothless maxillaries from the oral border, there is no mesocoracoid, the vertebral centra are solid and coossified with the arches, and the pelvic fins are placed well forward. Characteristic is the presence on each side of a supra-branchial cavity which contains a laminar

\* Communicated by permission of the Trustees of the British Museum.

† For explanation of the Plates see p. 787.

expansion or process of the first epibranchial; also the continuation backwards of the abdominal cavity, supported by ribs, nearly to the caudal fin, this caudal extension containing only the posterior part of the air-bladder. Another feature of some importance is the presence of teeth on the parasphenoid, between and just in front of the upper pharyngeals; in some genera these teeth form quite a well-marked patch, in others they are less prominent; in the very aberrant *Luciocephalus* I find only two or three minute teeth on the parasphenoid. The cranium of all the Labyrinthici is remarkably solid, the nasals are firmly united by suture to the frontals, the præorbitals to the præfrontals, and the postorbitals to the frontals and post-frontals; the suborbital ring is fixed and rigid; the supra-branchial cavities hollow out the otic region; as a rule they are bordered above by the laminar supra-temporal (ptertotic) and opisthotic, and within mainly by the exoccipitals, but in *Ophiocephalus* they reach the parietals, and in *Anabas* the supraoccipital and post-frontals also take part in roofing the suprabranchial cavities, which are only separated from each other in this type by a thin median septum, the cranial cavity being pushed forward. The post-temporal is forked, attached to the epiotic above and the opisthotic below; the ribs are inserted on strong transverse processes.

The Ophiocephaloidei are undoubtedly the most primitive sub-order; in them all the fin-rays are articulated and the 6-rayed pelvic fins are subabdominal in position, the pelvic bones being remote from the cleithra. The suprabranchial organ is not labyrinthic and the long simple air-bladder extends back for the whole length of the anal fin, the basalia of the latter being attached not to hæmal spines, but to the distal ends of the ribs.

In the Anabantoidi the pelvic fins are composed of a spine and five or fewer soft rays or may be reduced to a single filamentous ray, and the pelvic bones are attached to the ligament which connects the cleithra above their symphysis, either loosely or more or less firmly. The suprabranchial lamina is often branched and convoluted and the air-bladder is divided posteriorly by the hæmal spines which support the basalia of the anal fin.

The Ophiocephaloidei probably originated from fishes very similar to the Cyprinodontidæ, which like them are soft-rayed fishes with 6-rayed pelvic fins and with a scaly head, and which resemble them in the structure of the mouth and in many details of the cranium, vertebral column, and pectoral arch.

I follow Bleeker and Günther in recognizing two families of the Anabantoidi, viz. Anabantidæ, with the mouth moderately protractile and the gill-openings restricted by the broad union of the scaly gill-membranes, and Luciocephalidæ, with the mouth very protractile and the gill-openings wide, the naked gill-membranes not being united.

The Labyrinthici inhabit the Ethiopian and Oriental Regions, but two species, *Anabas scandens* and *Ophiocephalus striatus*, cross

Wallace's Line into Celebes, Amboina, and Halmahera\*. As a group they are remarkable for the time they can live out of water and for their habit of migrating overland from one pond or stream to another. One species, *Anabas scandens*, is said habitually to climb trees.

### Family ANABANTIDÆ.

#### *Synopsis of the Asiatic Genera.*

- |  |                            |
|--|----------------------------|
| I. Each pelvic fin of a spine and 5 soft rays.   |                            |
| A. First soft ray of pelvic fin bifid; two lateral lines, the lower commencing below the end of the upper and separated from it by a series of scales; dorsal spines numerous. |                            |
| 1. Jaws with fixed conical teeth.  |                            |
| Vomerine teeth; pelvic fins inserted a little behind the base of the pectorals .....   | 1. <i>Anabas</i> .         |
| Palate toothless; pelvic fins inserted below the base of the pectorals .....   | 2. <i>Polyacanthus</i> .   |
| 2. Jaws with small movable teeth attached to the thick lips .....  | 3. <i>Helostoma</i> .      |
| B. First soft ray of pelvic fin produced into a single filament.   |                            |
| 1. Lateral line present, complete and continuous ...   | 4. <i>Osphromenus</i> .    |
| 2. Lateral line vestigial or absent.   |                            |
| D. XIII-XVII 5-8. A. XVI-XX 9-15; præorbital serrated; dorsal and anal scaly at the base .....   | 5. <i>Macropodus</i> .     |
| D. XIII 7. A. XIII 9; præorbital entire; dorsal and anal scaleless .....   | 6. <i>Parosphromenus</i> . |
| D. VIII-XII 7-10. A. VIII-X 18-22; præorbital and lower limb of præoperculum serrated; origin of dorsal over spinous part of anal .....  | 7. <i>Sphærichthys</i> .   |
| D. II-VI 6-8. A. IV-VIII 24-28; præorbital and præoperculum serrated; origin of dorsal over soft part of anal .....  | 8. <i>Ctenops</i> .        |
| D. I 7-10. A. IV 20-37; præorbital and præoperculum entire .....   | 9. <i>Betta</i> .          |
| II. Each pelvic fin of a vestigial spine adnate to a long filamentous ray, which has 2 or 3 small branched rays in its axil .....  | 10. <i>Trichopodus</i> .   |
| III. Each pelvic fin reduced to a single long filamentous ray .....  | 11. <i>Trichogaster</i> .  |

\* All available evidence is strongly against the supposition that these three islands have been connected with each other and with Borneo or the Philippines during the life-time of these two species. Both are common and widely distributed fishes, much appreciated as food, and are so easily kept alive that the natives carry them about in jars, either with or without water, in order to have a supply of fresh fish ready. Thus nothing is more likely than that both species were introduced into Celebes, Amboina, and Halmahera by man; once introduced their peculiar powers of migration would soon enable them to spread all over these islands. These remarks apply also to *Monopterus javanensis*, another Indian species found in Celebes, an important food-fish able to live for a long time out of the water, which is kept alive in jars by the natives of the countries in which it occurs.

An Indian Symbranchoid eel, *Symbranchus bengalensis*, is known not only from Celebes but from Western Australia; this is essentially a brackish-water fish and there can be little doubt it sometimes descends to the sea.

An endemic Cyprinodont, *Haplochilus celebensis*, is the only remaining fish which has been supposed to indicate the Indian affinities of the freshwater fish fauna

## 1. ANABAS.

*Anabas*, Cuv. Règne Anim. ii. p. 310 (1817); Günth. Cat. Fish. iii. p. 374 (1861); Bleek. Verh. Akad. Amst. xix. 1879, p. 4.

Body oblong, subcylindrical anteriorly and compressed posteriorly. Small fixed conical teeth in the jaws and on the vomer. Præorbital, operculum, sub- and inter-operculum serrated. Dorsal with XVI-XIX 7-11 rays; origin in advance of that of the anal, which has IX-XI 8-12 rays; soft dorsal and anal scaly at the base and with the rays branched. Pelvics inserted a little behind the pectorals, of a spine and 5 branched rays; first branched ray only bifid. Scales large, regularly arranged; lateral line interrupted below the posterior part of the spinous dorsal, commencing again lower down.

The African genus *Spirobranchus* appears to me to be well distinguished from *Anabas* by the strongly compressed head and body, the presence of teeth on the palatines, the exposed maxillary, the entire præorbital and opercular bones, and the fewer fin-spines. *Ctenopoma* is much nearer to *Anabas*, but the Asiatic genus is well distinguished from both the African ones in that the postorbitals are large plates which cover the cheeks and are united by suture with the præoperculum, whilst the supra-branchial cavities are so large that they are roofed in by the parietals and supraoccipital and are only separated from each other by a thin septum formed by the supraoccipital and exoccipitals.

A single species from India, the Malay Peninsula and Archipelago.

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of Celebes, but as it belongs to a family and a genus which includes many marine forms it has little significance.

To illustrate the geographical distribution of freshwater fishes a primary division must be made separating the Australian Region, including Celebes, from the rest of the world. With the exception of (1) archaic types, *Ceratodus* and *Scleropages*, and (2) introduced species, such as *Anabas scandens*, the freshwater fishes of the Australian region belong to marine families, genera, or species. Ostariophysi are entirely absent except Siluroids of the marine groups Plotosidæ and Ariinæ; the perches are Serranidæ, Kuhlidiæ, etc.; peculiar genera and species of Atherinidæ, Mugilidæ, Gobiidæ, etc., form an important element in the freshwater fish fauna. The contrast between Borneo with its hundreds of species of Cyprinoids and freshwater Siluroids, Ophiocephalidæ, Anabantidæ, Luciocephalidæ, Nandidæ, and Mastacembelidæ, and Celebes from which these groups are entirely absent except for two species which cannot be regarded as indigenous, is most striking. The conclusion is that Wallace's Line indicates where the severance of Australia from Asia took place not later than the beginning of the Eocene.

I have been led to make these remarks by Prof. Max Weber's conclusion that the fish-fauna of Celebes has no Australian, but an impoverished Indian character (Zool. Ergebn. Reis. Ned. Ind. iii. 1894, p. 472). As I have shown above, the Indian element consists of three species which have probably been introduced by man and two which may have journeyed by sea. Prof. Max Weber also lays stress on the absence from Celebes of true Australian freshwater fishes, but I am unable to recognize this element in Australia itself; the Dipneusti and Osteoglossidæ, which are also absent from New Guinea, but one of which is represented in Borneo, are to be regarded, wherever they may occur, as survivors of an ancient fauna. Of the other genera mentioned by Prof. Max Weber, *Galaxias* is southern and marine, and is not found within a thousand miles of Celebes, whilst *Oligorus* is a perch found in the rivers of Eastern Australia, and belongs to the marine family Serranidæ.



## 1. ANABAS SCANDENS.

*Perca scandens* Daldorff, Trans. Linn. Soc. iii. 1797, p. 62.

*Anthias testudineus* Bloch, Ausl. Fisch. vi. p. 121, pl. cccxxii. (1795).

*Amphiprion testudineus* Schneid. Bloch's Syst. Ichth. p. 204 (1801).

*Amphiprion scansor* Schneid. t. c. p. 570.

*Lutianus testudo* Lacep. Hist. Nat. Poiss. iv. p. 235 (1803).

*Lutianus scandens* Lacep. t. c. p. 239.

*Sparus testudineus* Shaw, Zool. iv. p. 471 (1803).

*Sparus scandens* Shaw, t. c. p. 475.

*Cojus cobojius* Buch. Ham. Fish. Ganges, pp. 98, 370, pl. xiii. fig. 33 (1822).

*Anabas testudineus* Cuv. Règne Anim. ii. p. 310 (1817); Bleek. Atl. Ichth. pl. cccxvi. figs. 2, 3 (1878), and Verh. Akad. Amst. xix. 1879, p. 7.

*Anabas scandens* Cuv. & Val. Hist. Nat. Poiss. vii. p. 249, pl. exciii. (1831); Günth. Cat. Fish. iii. p. 375 (1861); Day, Fish. Ind. p. 370, pl. lxxviii. fig. 3 (1878).

*Anabas spinosus* Gray, Ill. Ind. Zool. ii. pl. lxxxix. fig. 1 (1834).

*Anabas variegatus* Bleek. Nat. Tijdschr. Ned. Ind. ii. 1851, p. 220.

*Anabas macrocephalus* Bleek. Nat. Tijdschr. Ned. Ind. vii. 1854, p. 430; Günth. t. c. p. 376.

*Anabas oligolepis* Bleek. Nat. Tijdschr. Ned. Ind. viii. 1855, p. 161; Atl. Ichth. pl. cccxv. fig. 5 (1878), and Verh. Akad. Amst. xix. 1879, p. 5; Günth. l. c.

*Anabas microcephalus* Bleek. Act. Soc. Sci. Ind. Neerl. ii. 1857, No. 7, p. 58; Atl. Ichth. pl. cccxv. fig. 2, and Verh. Akad. Amst. xix. 1879, p. 10; Günth. t. c. p. 377.

*Anabas trifoliatus* Kaup, Arch. f. Nat. 1860, p. 124, pl. vi. fig. A.

Dorsal with XVI–XIX 7–11 rays; anal with IX–XI 8–12. 27 to 32 scales in a longitudinal series. Greenish olive; usually two dark stripes from the eye to the opercles; sides of the body sometimes with dark cross-bands, sometimes with longitudinal stripes; often a blackish spot, which may be ocellated, at the base of the caudal fin; markings disappearing with age, the adults uniform or nearly so.

*Hab.* India; Ceylon; Malay Peninsula and Archipelago, to the Philippines, Celebes, Amboina, and Halmahera.

Günther in 1861 recognized four species, *A. scandens*, *macrocephalus*, *oligolepis*, and *microcephalus*. Bleeker in 1879 united *macrocephalus* with *scandens* and expressed doubt as to the validity of *microcephalus*. These three supposed species were based only on differences in form and proportions, but *A. oligolepis* was said to differ in the fewer scales, 27 instead of 30 to 32. Day (Fish. India, p. 370) gave it as his opinion that a regular gradation existed between these numbers. I find the number of scales varies considerably, but I am unable to recognize more than one species after examination of a large series of specimens.

## 2. POLYACANTHUS.

*Polyacanthus* (part.) Cuv. & Val. Hist. Nat. Poiss. vii. p. 353 (1831); Günth. Cat. Fish. iii. p. 378 (1861).

*Polyacanthus* Bleek. Verh. Ak. Amst. xix. 1879, p. 12.

Body oblong, compressed. Jaws with fixed conical teeth; palate toothless. Præoperculum serrated. Dorsal with XIV-XIX 8-11 rays; origin in advance of that of the anal, which has XIV-XVII 10-13 rays; soft dorsal and anal scaly at the base and with the rays branched. Pelvics inserted below the pectorals, of a spine and 5 branched rays, the first of which is produced into two filaments. Scales large, regularly arranged; lateral line interrupted below the posterior part of the spinous dorsal, commencing again lower down.

Two species from Ceylon and the Malay Archipelago.

## 1. POLYACANTHUS HASSELTII.

*Polyacanthus hasseltii* Cuv. & Val. Hist. Nat. Poiss. vii. p. 353, pls. cxcv., cv. (1831); Günth. Cat. Fish. iii. p. 378 (1861); Bleek. Atl. Ichth. pl. ccxcvi. fig. 7 (1878) and Verh. Ak. Amst. xix. 1879, p. 12.

*Polyacanthus kuhlii* Bleek. Nat. Gen. Arch. Ned. Ind. ii. 1845, p. 520.

*Polyacanthus einthovenii* Bleek. Nat. Tijdschr. Ned. Ind. ii. 1851, p. 423; Günth. l. c.

*Polyacanthus helfrichii* Bleek. Nat. Tijdschr. Ned. Ind. viii. 1855, p. 162; Günth. t. c. p. 379.

Præorbital not serrated; maxillary extending to the vertical from between the nostrils; interorbital width more than  $\frac{1}{3}$  the length of head. Dorsal XVI-XIX 10-13. Anal XV-XVII 11-13. 31 to 33 scales in a longitudinal series. Olivaceous; young with darker cross-bars; sometimes a blackish spot at the base of the soft dorsal; soft vertical fins sometimes with series of small dark spots or with reticulating lines.

*Hab.* Java, Sumatra, and Borneo.

A single specimen, 160 mm. in total length.

## 2. POLYACANTHUS SIGNATUS. (Plate LXXVII. fig. 5.)

*Polyacanthus signatus* Günth. Cat. Fish. iii. p. 379 (1861); Day, Fish. Ind. p. 371 (1878).

Præorbital serrated; maxillary extending to the vertical from the anterior margin of eye; interorbital width  $\frac{1}{4}$  or a little more than  $\frac{1}{4}$  the length of head. Dorsal XVI-XVIII 7-10. Anal XIV-XVII 9-12. 29 to 32 scales in a longitudinal series. Olivaceous; usually a dark spot at the base of the soft dorsal fin.

*Hab.* Ceylon.

Twelve specimens, measuring up to 130 mm. in total length, including the types of the species.

## 3. HELOSTOMA.

*Helostoma* Cuv. & Val. Hist. Nat. Poiss. vii. p. 341 (1831); Canestr. Verh. Zool.-Bot. Gesellsch. x. 1860, p. 705; Günth. Cat. Fish. iii. p. 377 (1861); Bleek. Verh. Ak. Amst. xix. 1879, p. 14.

Body rather deep, compressed. Lips thick, with small movable teeth; palate toothless. Præorbital serrated; præoperculum entire. Dorsal with XII-XVIII 13-16 rays; origin in advance of that of the anal, which has VIII-XV 17-19 rays; soft dorsal and anal scaly at the base and with the rays branched. Pelvics inserted below the pectorals, of a spine and 5 branched rays, the first of which is bifid and somewhat produced. Scales of moderate size, regularly arranged; lateral line interrupted below the soft dorsal, commencing again lower down.

One species from Siam, the Malay Peninsula and Archipelago.

## 1. HELOSTOMA TEMMINCKII.

*Helostoma temminckii* Cuv. & Val. Hist. Nat. Poiss. vii. p. 342, pl. exciv. (1831); Günth. Cat. Fish. iii. p. 377 (1861); Bleek. Atl. Ichth. pl. ccxcvi. fig. 5 (1878) and Verh. Ak. Amst. xix. 1879, p. 15.

Depth of body  $\frac{1}{2}$  or a little more than  $\frac{1}{2}$  the length. Dorsal XVI-XVIII 13-16. Anal XIII-XV 17-19. 43 to 48 scales in a longitudinal series. Dark longitudinal stripes along the series of scales.

*Hab.* Siam; Malay Peninsula; Java, Sumatra, and Borneo

Five specimens, measuring up to 200 mm. in total length.

A specimen from Java with XII 14 dorsal and VIII 17 anal rays received the name *H. oligacanthum*, but was afterwards regarded by Dr. Bleeker as merely an abnormal example (Verh. Ak. Amst. xix. 1879, p. 16).

## 4. OSPHROMENUS.

*Osphromenus* Lacep. Hist. Nat. Poiss. iii. p. 117 (1802); Cuv. & Val. Hist. Nat. Poiss. vii. p. 377 (1831); Canestr. Verh. Zool.-Bot. Gesellsch. x. 1860, p. 706; Bleek. Verh. Ak. Amst. xix. 1879, p. 17.

*Osphromenus* (part.) Günth. Cat. Fish. iii. p. 382.

Body deep, compressed. Jaws with fixed conical teeth; palate toothless. Præorbital, præoperculum, and interoperculum serrated. Dorsal with XI-XIII 11-13 rays; origin above that of the anal, which has IX-XII 16-22 rays; anal scaly at the base and with most of the rays branched. Pelvics inserted below the pectorals, of a spine and 5 soft rays; first soft ray produced into a filament. Scales large, regularly arranged; lateral line complete, continuous.

A single species from the Malay Archipelago.

1. *OSPHROMENUS GOURAMI*.

*Osphromenus gourami* Lacep. Hist. Nat. Poiss. iii. p. 117, pl. iii. fig. 2 (1802); Cuv. & Val. Hist. Nat. Poiss. vii. p. 377, pl. excviii. (1831).

*Osphromenus olfax* Cuv. Règne Anim. ii. p. 336 (1817); Cuv. & Val. l. c.; Günth. Cat. Fish. iii. p. 382 (1861); Day, Fish. Ind. p. 372, pl. lxxix. fig. 6 (1878); Bleek. Atl. Ichth. pls. ccxcv. fig. 6 and ccxcvi. fig. 6 (1878); and Verh. Ak. Amst. xix. 1879, p. 17.

*Osphromenus notatus* Cuv. & Val. t. c. p. 386.

Body deep, compressed. Dorsal XI-XIII 11-13. Anal IX-XII 16-22. 30 to 35 scales in a longitudinal series. Adult uniformly olivaceous; young with oblique darker cross-bands, a blackish spot at the base of the pectoral and another above the posterior part of the anal.

*Hab.* Java, Sumatra, and Borneo; introduced into various tropical countries.

Numerous examples measuring up to 450 mm. in total length, from Borneo (*Hose, Cator*) and Sumatra (*Moesch*), and also from Penang (*Cantor*), Madras, Mauritius, and the Seychelles.

The species attains a large size and a weight of more than 20 lbs.; it is an excellent food-fish.

5. *MACROPODUS*.

*Macropodus* Lacep. Hist. Nat. Poiss. iii. p. 417 (1802).

*Pseudosphromenus* Bleek. Verh. Ak. Amst. xix. 1879, p. 17.

Body oblong, compressed. Jaws with fixed conical teeth; palate toothless. Præorbital and præoperculum serrated. Dorsal with XIII-XVII 5-8 rays; origin nearly above that of the anal, which has XVI-XX 9-15 rays; a scaly sheath at the base of dorsal and anal fins; rays branched. Pelvic fins inserted below the pectorals, of a spine and 5 soft rays; first soft ray produced into a filament. Scales large, regularly arranged; lateral line vestigial or absent.

Two species from China, India, and the Malay Peninsula.

1. *MACROPODUS OPERCULARIS*.

*Labrus opercularis* Linn. Amæn. Acad. iv. p. 248 (1788).

*Chatodon chinensis* Bloch, Ausl. Fisch. pl. cexviii. fig. 1 (1790).

*Macropodus viridiauratus* Lacep. Hist. Nat. Poiss. iii. p. 417, pl. xvi. fig. 1 (1802); Cuv. & Val. Hist. Nat. Poiss. vii. p. 373 (1831); Günth. Cat. Fish. iii. p. 382 (1861).

*Polyacanthus chinensis* Cuv. & Val. t. c. p. 357; Richards. Ichth. China, p. 250 (1846).

*Macropodus venustus* Cuv. & Val. t. c. p. 375, pl. excvii.

*Macropodus ocellatus* Cant. Ann. Mag. N. H. ix. 1842, p. 484.

*Polyacanthus opercularis* Richards. l. c.; Günth. t. c. p. 379.

*Polyacanthus paludosis* Richards. l. c.



Depth of body  $\frac{1}{3}$  or more than  $\frac{1}{3}$  of the length. Dorsal XIII-XVII 6-8. Anal XVII-XX 11-15. Small scales on the fins in addition to the basal sheath; soft vertical fins sometimes produced, when the caudal becomes bilobed. 28 to 31 scales in a longitudinal series. A round black spot on the extremity of the operculum; body with or without dark cross-bars, sometimes with irregular silvery bars.

*Hab.* China; Cochin China; Formosa; Loo Choo Islands.

Several specimens, measuring up to 80 mm. in total length, including the types of *M. ocellatus*.

## 2. MACROPODUS CUPANUS.

*Polyacanthus cupanus* Cuv. & Val. Hist. Nat. Poiss. vii. p. 357 (1831); Günth. Cat. Fish. iii. p. 381 (1861); Day, Fish. Ind. p. 371, pl. lxxviii. fig. 4 (1878).

Depth of body about  $\frac{1}{3}$  the length. Dorsal XIV-XVII 5-7. Anal XVI-XIX 9-11. Fins scaleless except for the basal sheath; soft vertical fins sometimes produced, when the caudal becomes pointed. 29 to 32 scales in a longitudinal series. A dark spot on each side at the base of the caudal fin; body sometimes with two dark longitudinal bands, rarely with irregular cross-bars.

*Hab.* India; Ceylon; Malay Peninsula; in lowland streams and estuaries.

Eighteen specimens, measuring up to 45 mm. in total length.

## 6. PAROSPHROMENUS.

*Parosphromenus* Bleek. Verh. Ak. Amst. xix. 1879, p. 19.

Body rather elongate, compressed. Jaws with fixed conical teeth; palate toothless. Præorbital and opercular bones, except the præoperculum, not serrated. Dorsal with XIII 7 rays; origin in advance of that of the anal, which has XIII 9 rays; dorsal and anal fins scaleless and with simple rays. Pelvics inserted below the pectorals, of a spine and 5 soft rays; first soft ray produced into a filament. Scales large, regularly arranged; lateral line vestigial or absent.

A single species, from Sumatra.

### 1. PAROSPHROMENUS DEISSNERI.

*Osphromenus deissneri* Bleek. Nat. Tijdschr. Ned. Ind. xviii. 1859, p. 376.

*Polyacanthus deissneri* Günth. Cat. Fish. iii. p. 381 (1861).

*Parosphromenus deissneri* Bleek. Atl. Ichth. pl. cccxcv. fig. 1 (1878), and Verh. Ak. Amst. xix. 1879, p. 20.

Depth of body  $3\frac{2}{3}$  in the length. Dorsal XIII 7. Anal XIII 9. 30 scales in a longitudinal series. Body with blackish longitudinal stripes, a mid-dorsal and a mid-ventral and two broader ones on each side.

*Hab.* Bangka, Sumatra.

Total length 34 mm.

## 7. SPHÆRICHTHYS.

*Sphærichthys* Canestrini, Verh. Zool.-Bot. Gesellsch. x. 1860, p. 707.

Body deep, compressed. Jaws with very small, fixed teeth; palate toothless. Præorbital and lower limb of præoperculum serrated. Dorsal with VIII-XII 7-10 rays; origin a little behind that of the anal, which has VIII-X 18-22 rays; anal scaly at the base and with the rays simple. Pelvics inserted a little in advance of the pectorals, each of a spine and 5 soft rays, the first somewhat produced; scales large, regularly arranged; lateral line vestigial or absent.

A single species from the Malay Peninsula.

## 1. SPHÆRICHTHYS OSPHROMENOIDES.

*Sphærichthys osphromenoides* Canestrini, Verh. Zool.-Bot. Gesellsch. x. 1860, p. 707.

*Osphromenus malayanus* Duncker, Monatsb. Mus. Hamburg, xxi. 1904, p. 163, pl. i. fig. 8.

Body deep, compressed. Dorsal VIII-XII 7-10. Anal VIII-X 18-22. 26 to 29 scales in a longitudinal series. Brownish; four whitish nearly vertical stripes on the posterior part of the fish, of which one connecting the posterior dorsal and anal spines and a second running downwards from the end of the dorsal fin are the most conspicuous, the third and fourth bordering a dark spot on the upper part of the base of the caudal; sometimes a similar stripe on the head, running obliquely from the temporal region to the base of the pelvic fins.

*Hab.* Malay Peninsula.

Two specimens, types of *O. malayanus*, 40 mm. in total length, from Kuala Lumpur (*Robinson*).

## 8. CTENOPS.

*Ctenops* McClelland, Calc. Journ. Nat. Hist. v. 1844, p. 281.

*Trichopsis* (Kner) Canestr. Verh. Zool.-Bot. Gesellsch. x. 1860, p. 708.

Body oblong, compressed. Jaws with fixed conical teeth. Præorbital and præoperculum serrated. Dorsal with II-VII 6-8 rays, commencing above the anal, which has IV-VIII 24-28 rays; anal scaly at the base, with simple rays. Pelvics inserted a little in advance of the pectorals, each of a spine and five soft rays, the first produced into a filament. Scales large, regularly arranged; lateral line vestigial or absent.

Two species from India, Cochin China, Siam, and the Malay Archipelago.

## 1. CTENOPS VITTATUS.

*Osphromenus vittatus* Cuv. & Val. Hist. Nat. Poiss. vii. p. 387 (1831).

*Trichopsis striatus* Bleek. Verh. Batav. Genootsch. xxiii. 1850, no. 8, p. 11.

*Osphromenus striatus* Günth. Cat. Fish. iii. p. 386 (1861).

*Ctenops striatus* Bleek. Atl. Ichth. pl. cccxvi. (1878), and Verh. Ak. Amst. xix. 1879, p. 24.

Depth of body  $2\frac{1}{2}$  to 3 in the length. Snout shorter than eye. Dorsal II-IV 6-8. Anal VI-VII 24-28. 28 scales in a longitudinal series. Body with dark longitudinal stripes, on each side two from the eye to the caudal fin, the upper bearing a humeral spot; usually two more stripes on each side, one above ending just behind the dorsal fin, the other from the chin through the base of the pectoral to the end of the anal.

*Hab.* Cochin China, Siam, Java, Sumatra, and Borneo. Seven specimens, measuring up to 60 mm. in total length, from Cochin China (*Paris Mus.*), Siam (*Mouhot*), and Java.

## 2. CTENOPS NOBILIS.

*Ctenops nobilis* McClell. Calc. Journ. Nat. Hist. v. 1844, p. 281, pl. xxi. fig. 1.

*Osphromenus nobilis* Day, Fish. Ind. p. 372, pl. lxxviii. fig. 5 (1878).

Depth of body  $2\frac{1}{2}$  to 3 in the length. Snout longer than eye. Dorsal V-VII 7-8. Anal IV-V 24-28. 29 to 33 scales in a longitudinal series. Brownish, with darker stripes along the series of scales and with scattered blackish spots; a silvery white stripe, more or less interrupted, from eye to base of caudal; below it two similar stripes or series of oblong spots; fins with small dark spots; an ocellus on the upper part of the base of the caudal.

*Hab.* North-eastern Bengal and Assam.

Eight specimens, measuring up to 75 mm. in total length, from N.E. Bengal (*Jerdon*).

## 9. BETTA.

*Betta* Bleek. Verh. Batav. Genootsch. xxiii. 1850, no. 8, p. 12, and Verh. Ak. Amst. xix. 1879, p. 26; Günth. Cat. Fish. iii. p. 388 (1861).

*Paraphiocephalus* Popta, Notes Leyden Mus. xxv. 1905, p. 184, and xxvii. 1906, p. 9.

Body moderately elongate, more or less compressed. Jaws with fixed conical teeth; palate toothless. Præorbital and opercular bones entire. Dorsal without or with a single spine and with 7 to 11 soft rays; origin above the anal; anal without or with 1 to 4 spines and with 20 to 37 soft rays; pelvics inserted below or a little in advance of the pectorals, of a spine and 5 soft rays, the outermost of which is more or less produced. Scales large, regularly arranged; lateral line vestigial or absent.

Fourteen species from Siam, the Malay Peninsula and Archipelago.

*Micracanthus* Sauvage, from the Ogowe, with III 7 dorsal and IV 23 anal rays, appears to be closely allied to *Otenops* and *Betta*, but differs in having only 4 soft rays in the pelvic fin.

*Synopsis of the Species.*

- I. All the rays of the dorsal and anal fins articulated (*Parophiocephalus*).
- a. Anal with 26 to 30 rays.
- Maxillary extending beyond middle of eye ..... 1. *macrostoma*.  
 Maxillary not extending beyond anterior edge of eye ..... 2. *unimaculata*.
- b. Anal with 34 to 37 rays ..... 3. *bellica*.
- II. Anal fin with one to four spines (*Betta*).
- A. All the rays of the dorsal fin flexible, articulated;  
 maxillary extending to below nostrils or anterior  
 edge of eye.
1. Anal with I 27 rays ..... 4. *akarensis*.  
 2. Anal with II 25-29 rays.
- Length of head  $3$  to  $3\frac{1}{4}$  (adult) in the length of the fish ..... 5. *pugnax*.  
 Length of head  $3\frac{1}{4}$  (young) to  $3\frac{3}{4}$  (adult) in the length of the  
 fish ..... 6. *anabatoides*.  
 3. Anal with II 21-24 rays ..... 7. *fusca*.
- B. First dorsal ray a more or less pungent spine.
1. Maxillary extending to below anterior part of  
 eye ..... 8. *bleekeri*.  
 2. Maxillary extending to below posterior nostril or  
 anterior edge of eye.
- Anal with I 20 rays; 26 scales in a longitudinal series;  
 diameter of eye 4 in the length of head (in a specimen of  
 42 mm.) ..... 9. *trifasciata*.  
 Anal with I 23 rays; 28 scales in a longitudinal series;  
 diameter of eye 3 in the length of head (in a specimen of  
 50 mm.) ..... 10. *macrophthalma*.  
 Anal with II 20-22 rays; 28 or 29 scales in a longitudinal  
 series; diameter of eye  $3\frac{1}{4}$  to  $3\frac{1}{2}$  in the length of head (in  
 specimens of 50 to 60 mm.) ..... 11. *taniata*.  
 Anal with III 21 rays; 30 scales in a longitudinal series;  
 diameter of eye  $3\frac{2}{3}$  in the length of head (in a specimen  
 of 47 mm.) ..... 12. *rubra*.  
 3. Maxillary extending to the vertical from between  
 the nostrils.
- Anal with II-IV 22-24 rays ..... 13. *splendens*.  
 Anal with II 30 rays ..... 14. *fasciata*.

1. *BETTA MACROSTOMA*, sp. n. (Plate LXXVIII. fig. 3.)

Depth of body 4 in the length, length of head 3. Snout slightly longer than eye, the diameter of which is  $4\frac{1}{3}$  in the length of head; interorbital width  $2\frac{4}{5}$  in the length of head. Maxillary extending a little beyond the middle of eye. Dorsal 11. Anal 26. 32 scales in a longitudinal series. Two blackish longitudinal bands from eye to caudal fin; dorsal with series of dark spots and with a large black ocellus near the base posteriorly; caudal with two blackish cross-bars; other fins dusky.

*Hab.* Sarawak.

A single specimen, 80 mm. in total length, collected by Dr. C. Hose.



## 2. BETTA UNIMACULATA.

*Parophiocephalus unimaculatus* Popta, Notes Leyden Mus. xxv. 1905, p. 184, and xxvii. 1906, p. 10, pl. i. fig. 1.

Depth of body 4 in the length, length of head  $3\frac{1}{2}$ . Snout as long as eye, the diameter of which is  $4\frac{1}{4}$  in the length of head; interorbital width  $2\frac{2}{3}$  in the length of head. Maxillary extending to below posterior nostril or anterior edge of eye. Dorsal 9. Anal 30. 33 scales in a longitudinal series. Olivaceous; a blackish spot at the base of the caudal fin; fins dusky, the dorsal and caudal with series of small blackish spots.

*Hab.* Borneo.

A single specimen, 70 mm. in total length, from the River Bongon, N. Borneo, collected by Mr. A. Everett.

Popta's description is based on numerous specimens from the Howong and Kajan Rivers, 38 to 82 mm. in total length. She gives the following numbers:—Dorsal 7–8. Anal 27–30. 32 scales in a longitudinal series.

## 3. BETTA BELLICA.

*Betta bellica* Sauvage, Bull. Soc. Zool. France, ix. 1884, p. 217, fig.

Depth of body 4 in the length, length of head about  $4\frac{2}{3}$ . Dorsal 10. Anal 37 (34 according to the figure). 35 scales in a longitudinal series. Anterior half of each scale emerald-green, the rest bronze; fins dusky.

*Hab.* Perak.

Total length, 90 mm.

## 4. BETTA AKARENSIS, sp. n. (Plate LXXVII. fig. 3.)

Depth of body  $3\frac{1}{2}$  in the length, length of head 3. Snout shorter than eye, the diameter of which is  $3\frac{1}{3}$  in the length of head and nearly equal to the interorbital width. Maxillary extending to below the posterior nostril. Dorsal 8. Anal 27. 31 scales in a longitudinal series. Brownish, with darker stripes along the series of scales; a dark longitudinal band on the head, passing through the eye; fins dusky.

*Hab.* River Akar, Sarawak.

A single specimen, 52 mm. in total length, collected by Dr. C. Hose.

## 5. BETTA PUGNAX.

*Macropodus pugnax* Cantor, Cat. Malay Fish. p. 84, pl. ii. figs. 1–3 (1850).

*Betta pugnax* Günth. Cat. Fish. iii. p. 389 (1861).

Depth of body  $3\frac{1}{4}$  in the length, length of head 3 to  $3\frac{1}{4}$ . Snout shorter than eye, the diameter of which is  $3\frac{2}{5}$  in the length of head; interorbital width  $2\frac{1}{5}$  in the length of head. Maxillary extending to below posterior nostril or anterior edge of eye.

Dorsal 9-10; origin equidistant from head and base of caudal. Anal II 26. 30 to 32 scales in a longitudinal series. Olivaceous, with darker cross-bands; each scale on the side with a silvery dot; a blackish longitudinal stripe on the head, passing through the eye; fins, except the pectoral, pale reddish; margin of dorsal and anal, and pelvic filament greenish or golden.

*Hab.* Pinang.

Three specimens, including two skins, types of the species, 75 to 90 mm. in total length, from Dr. Cantor's collection.

6. *BETTA ANABATOIDES*. (Plate LXXVIII. fig. 4.)

*Betta anabatoides* Bleek. Nat. Tijdschr. Ned. Ind. i. 1850, p. 269.

Depth of body 3 to  $3\frac{3}{4}$  in the length, length of head  $3\frac{1}{4}$  to  $3\frac{3}{4}$ . Snout as long as or shorter than eye, the diameter of which is  $3\frac{1}{4}$  to  $4\frac{1}{2}$  in the length of head; interorbital width  $2\frac{1}{5}$  to  $2\frac{4}{5}$  in the length of head. Maxillary extending to below posterior nostril or anterior edge of eye. Dorsal 8-10; origin a little nearer to caudal fin than to head (in the adult). Anal II 25-29. 31 to 33 scales in a longitudinal series. Brownish; usually a dark stripe on the head passing through the eye, sometimes continued on the body and with another above it; fins dusky, the dorsal and caudal usually with series of dark spots.

*Hab.* Borneo.

Twenty specimens from Sarawak (*Cutter, Doria, Hose, Everett*), 55 to 120 mm. in total length, seem to belong to the species described by Bleeker from Bandjermassing, S.E. Borneo.

7. *BETTA FUSCA*, sp. n. (Plate LXXVIII. fig. 2.)

Depth of body  $3\frac{1}{3}$  to  $3\frac{1}{2}$  in the length, length of head  $3\frac{1}{3}$ . Snout shorter than eye, the diameter of which is  $3\frac{1}{4}$  to  $3\frac{1}{2}$  in the length of head; interorbital width  $2\frac{1}{4}$  to  $2\frac{1}{2}$  in the length of head. Maxillary nearly or quite extending to below the posterior nostril. Dorsal 9. Anal II 21-24. 31 or 32 scales in a longitudinal series. A dark longitudinal band through the eye; scales with dark edges; fins dusky.

*Hab.* Sumatra.

Two specimens, 82 mm. in total length, collected by Mr. W. Morton.

8. *BETTA BLEEKERI*, sp. n.

*Betta picta* (non Val.) Bleek. Atlas Ichth. ix. pl. cccxcv. fig. 3 (1877), and Verh. Ak. Amst. xix. 1879, p. 26.

Maxillary extending well beyond the vertical from anterior edge of eye. Dorsal I 9. Anal II 27. 34 scales in a longitudinal series. Olivaceous; dorsal with longitudinal stripes.

Bleeker's description is evidently chiefly based on specimens of the species figured in the Atlas.

9. *BETTA TRIFASCIATA*.

? *Panchax pictum* Cuv. & Val. Hist. Nat. Poiss. xviii. p. 385 (1846).

*Betta trifasciata* Bleek. Verhandl. Batav. Genootsch. xxiii. 1850, no. 8, p. 12; Günth. Cat. Fish. iii. p. 388 (1861).

Snout short; mouth small; diameter of eye 4 in head. Dorsal I 7. Anal I 20. 26 scales in a longitudinal series. Three black stripes from operculum to caudal fin.

*Hab.* Ambarawa, Central Java, 1500 ft.

Total length, 42 mm.

10. *BETTA MACROPHTHALMA*, sp. n. (Plate LXXVII. fig. 2.)

Depth of body  $3\frac{1}{2}$  in the length, length of head 3. Snout shorter than eye, the diameter of which is 3 in the length of head and nearly equal to the interorbital width. Maxillary extending to below posterior nostril. Dorsal I 8. Anal I 23. 28 scales in a longitudinal series. Traces of dark longitudinal stripes on the body.

*Hab.* Singapore.

A single specimen, 50 mm. in total length, from Prof. Peters's collection.

11. *BETTA TENIATA*, sp. n. (Plate LXXVIII. fig. 1.)

Depth of body  $3\frac{1}{3}$  to  $3\frac{2}{3}$  in the length, length of head 3. Snout shorter than eye, the diameter of which is  $3\frac{1}{4}$  to  $3\frac{1}{2}$  in the length of head; interorbital width 3 to  $3\frac{1}{4}$  in the length of head. Maxillary extending to below posterior nostril. Dorsal I 8. Anal II 20-22. 28 or 29 scales in a longitudinal series. Brownish; 2 or 3 blackish longitudinal bands on the side; fins dusky.

*Hab.* River Senah, Sarawak.

Four specimens, 50 to 60 mm. in total length, collected by Mr. A. Everett.

12. *BETTA RUBRA*. (Plate LXXVII. fig. 1.)

*Betta rubra* Perugia, Ann. Mus. Genova (2) xiii. 1893, p. 242.

Depth of body  $3\frac{3}{4}$  in the length, length of head  $3\frac{1}{4}$ . Snout shorter than eye, the diameter of which is  $3\frac{2}{3}$  in the length of head; interorbital width  $3\frac{1}{3}$  in the length of head. Maxillary extending to below the posterior nostril. Dorsal I 7. Anal III 21. 30 scales in a longitudinal series. Upper half of the body dark brownish; five or six dark vertical bars of the same colour descending on to the pale ground colour of the lower part of the side; vertical and pelvic fins reddish.

*Hab.* Lake Toba, Sumatra.

A single specimen, one of the types of the species, 47 mm. in total length.

13. *BETTA SPLENDENS*, sp. n.

*Betta pugnax*, var., Cantor, Cat. Malay Fish. p. 86, pl. ii. fig. 4 (1850).

*Betta pugnax* Waite, Rec. Austral. Mus. v. 1904, p. 293, pl. xxxviii.

Depth of body  $2\frac{5}{8}$  to  $3\frac{2}{3}$  in the length, length of head  $3\frac{1}{4}$  to  $3\frac{3}{5}$ . Snout as long as or shorter than eye, the diameter of which is  $3\frac{1}{2}$  to 4 in the length of head; interorbital width  $2\frac{2}{5}$  to 3 in the length of head. Maxillary extending to the vertical from between the nostrils. Dorsal I 8-9. Anal II-IV 21-24. 30 to 32 scales in a longitudinal series. Dark greenish olive above, red below; all the scales edged with black; a dark oblique stripe from eye to suboperculum; sometimes two dark longitudinal bands, with a pale band between them, from eye to caudal fin; gill-membranes blackish; dorsal rays black, membrane greenish with black undulating stripes; caudal rays red, membrane greenish; pelvics and anal red, with dark edges; pectoral pale.

*Hab.* Siam; Malay Peninsula.

Nine specimens, 35 to 55 mm. in total length, from Bangkok, the Menam River, and Pinang, collected by Captain S. S. Flower.

14. *BETTA FASCIATA*, sp. n. (Plate LXXVII. fig. 4.)

Depth of body  $3\frac{1}{2}$  to 4 in the length, length of head  $3\frac{2}{3}$  to  $4\frac{2}{5}$ . Snout shorter than eye, the diameter of which is 3 to  $3\frac{1}{2}$  in the length of head; interorbital width  $2\frac{2}{3}$  to 3 in the length of head. Maxillary extending to the vertical from between the nostrils. Dorsal I 9-10. Anal II 30. 34 to 36 scales in a longitudinal series. Brownish, with several somewhat oblique darker cross-bars; fins dusky, the dorsal with series of small dark spots, the pelvics and anal blackish.

*Hab.* Deli, Sumatra.

Two specimens, 65 and 90 mm. in total length, collected by Mr. Iversen.

## 10. TRICHOPODUS.

*Trichopodus* Lacep. Hist. Nat. Poiss. iii. p. 129 (1802); Canestrini, Verh. Zool.-Bot. Gesellsch. x. 1860, p. 708; Bleek. Verh. Ak. Amst. xix. 1879, p. 21.

*Trichopus* Cuv. & Val. Hist. Nat. Poiss. vii. p. 388 (1831).

*Osphromenus* (part.) Günth. Cat. Fish. iii. p. 382 (1861).

Body deep or moderately elongate, compressed. Jaws with fixed conical teeth; palate toothless. Præorbital, præ-, sub- and inter-operculum serrated. Dorsal with III-VIII 8-11 rays; origin above the anal, which has IX-XIV 25-39 rays; anal covered with scales except near the edge and with most of the rays simple; pelvics inserted a little in advance of the pectorals, with a vestigial spine adnate to the long simple ray, which has



2 or 3 small rays in its axil. Scales of moderate size, irregularly arranged; lateral line complete, but not continuous.

Four species from Cochin China, Siam, the Malay Peninsula and Archipelago.

*Synopsis of the Species.*

Dorsal with V-VII 8-10 rays, anal with XII-XIV 25-30; 30 to 36 scales in the lateral line and 44 to 50 in a longitudinal series above the lateral line .....	1. <i>leeri</i> .
Dorsal with VI-VIII 8-9 rays, anal with X-XII 33-37; 30 to 40 scales in the lateral line and 40 to 52 in a longitudinal series above the lateral line .....	2. <i>trichopterus</i> .
Dorsal with VII 10-11 rays, anal with IX-XI 36-38; 42 to 47 scales in the lateral line and 55 to 63 in a longitudinal series above the lateral line .....	3. <i>pectoralis</i> .
Dorsal with III-IV 8-10 rays, anal with X-XII 34-39; 35 to 42 scales in the lateral line and 58 to 65 in a longitudinal series above the lateral line .....	4. <i>microlepis</i> .

1. TRICHOPODUS LEERI. (Plate LXXIX. fig. 2.)

*Trichopus trichopterus* (part.) Cantor, Cat. Malay. Fish. p. 89 (1850).

*Trichopus leerii* Bleek. Nat. Tijdschr. Ned. Ind. iii. 1852, p. 577.

*Ophromenus trichopterus* var. *leerii* Günth. Cat. Fish. iii. p. 384 (1861).

*Trichopodus trichopterus* (part.) Bleek. Verh. Akad. Amst. xix. 1879, p. 21.

Depth of body  $2\frac{1}{4}$  to  $2\frac{3}{5}$  in the length. Diameter of eye  $1\frac{2}{5}$  in the length of postorbital part of head (in adult specimens of 100 to 110 mm.). Dorsal V-VII 8-10. Anal XII-XIV 25-30. Pectoral as long as the head. 30 to 36 scales in the lateral line, 44 to 50 in a longitudinal series above the lateral line. Body and vertical fins with pale greenish spots enclosed in a reddish-brown network; a dark longitudinal stripe from the snout through the eye, ending in a spot at the base of the caudal fin.

*Hab.* Malay Peninsula; Sumatra.

Eight specimens, measuring up to 110 mm. in total length, from Pinang (Cantor) and Sumatra (Moesch, Merrem).

2. TRICHOPODUS TRICHOPTERUS.

*Labrus trichopterus* Pall. Spicil. viii. p. 45 (1777); Gmelin, Linn. Syst. Nat. p. 1286 (1789); Bloch, Ausl. Fische, pl. ccxcv. fig. 2 (1792).

*Trichopodus trichopterus* Lacep. Hist. Nat. Poiss. iii. p. 129 (1802); Bleek. Atlas Ichth. ix. pl. ccxcv. fig. 4 (1878).

*Trichopus trichopterus* Cuv. & Val. Hist. Nat. Poiss. vii. p. 388, pl. cxcix. (1831).

*Trichopus trichopterus* (part.) Cantor, Cat. Malay Fish. p. 89 (1850).

*Osphromenus trichopterus* vars. *koelreuteri* and *cantoris* Günth. Cat. Fish. iii. p. 384 (1861).

*Osphromenus siamensis* Günth. t. c. p. 385.

*Trichopodus trichopterus* (part.) Bleek. Verh. Akad. Amst. xix. 1879, p. 21.

Depth of body 2 to  $2\frac{3}{5}$  in the length. Diameter of eye 2 in the length of the postorbital part of head (in adult specimens of 100 to 120 mm.). Dorsal VI–VIII 8–9. Anal X–XII 33–37. Pectoral as long as the head. 30 to 40 scales in the lateral line and 40 to 52 in a longitudinal series above the lateral line. Head and body with or without somewhat oblique dark brown cross-bands, which may be broken up into spots; a round black spot on the middle of the side and another at the base of the caudal fin; sometimes a blackish lateral band through the spots, from eye to caudal fin; dorsal, caudal, and posterior part of anal with alternate series of pale and dark spots, the latter sometimes forming reticulations.

*Hab.* Cochin China; Siam; Malay Peninsula and Archipelago.

Here described from numerous specimens, measuring up to 120 mm. in total length, from Cochin China (*Paris Mus.*), Siam (*Mouhot*, *Day*, *Flower*, *Siamese Mus.*), Pinang (*Cantor*), Sumatra (*Moesch*) and Java.

### 3. TRICHOPODUS PECTORALIS, sp. n. (Plate LXXIX. fig. 1.)

Depth of body  $2\frac{1}{5}$  to 3 in the length. Diameter of eye a little less than  $\frac{1}{2}$  the length of the postorbital part of the head. Dorsal VII 10–11. Anal IX–XI 36–38. Pectoral longer than the head. 42 to 47 scales in the lateral line and 55 to 63 in a longitudinal series above the lateral line. Head and body with oblique dark cross-bands; an interrupted lateral band from eye to caudal fin, sometimes present on the head only; fins without spots, or a few pale spots on the basal part of the caudal.

*Hab.* Siam; Malay Peninsula.

Six specimens, 140 to 160 mm. in total length, from Siam (*Jamrach*, *Siamese Mus.*) and Singapore (*Vipan*).

### 4. TRICHOPODUS MICROLEPIS.

*Osphromenus microlepis* Günth. Cat. Fish. iii. p. 385 (1861).

*Trichopus parvipinnis* Sauv. Nouv. Arch. Mus. (2) iv. 1881, p. 165, pl. vi. fig. 3.

Depth of body 2 in the length. Diameter of eye 2 in the length of postorbital part of head (in adult specimens of 150 mm.). Dorsal III–IV 8–10. Anal X–XII 34–39. Pectoral longer than the head. 35 to 42 scales in the lateral line and 58 to 65 in a longitudinal series above the lateral line. Silvery; back greenish; dorsal and caudal fins with little blackish spots.

*Hab.* Siam and Cambojia.

Three specimens, 90 to 150 mm. in total length, including the

types of the species and of *T. parvipinnis*, from Bangkok (*Paris Mus.*), the Menam River (*Siamese Mus.*), and Cambojia (*Mouhot*).

# 11. TRICHOGASTER.

*Trichogaster* Schneid. Bloch's Syst. Ichth. p. 164 (1801); Günth. Cat. Fish. iii. p. 387 (1861).

*Colisa* Cuv. & Val. Hist. Nat. Poiss. vii. p. 359 (1831); Canestr. Verh. Zool.-Bot. Gesellsch. x. 1860, p. 705.

Body oblong, compressed. Jaws with fixed conical teeth; palate toothless. Præorbital and præoperculum serrated. Dorsal with XV-XIX 6-14 rays; origin above or a little in advance of that of the anal, which has XIV-XXII 11-20 rays; anal scaly at the base and with the soft rays branched. Pelvics inserted in advance of the pectoral, reduced to a single filamentous ray. Scales large, regularly arranged. Lateral line sometimes absent or vestigial, usually present and comprising an upper anterior and a lower posterior portion, which may be connected by 1 to 4 pierced scales of the intermediate series.

Five species from India and Burmah.

## *Synopsis of the Species.*

I. Anal fin more or less scaly, the scales not covering the fin to the tips of the spines.

Dorsal XV-XVII 9-14. Anal XV-XVIII 14-19. 29 to 31 scales in a longitudinal series .....	1. <i>fasciatus</i> .
Dorsal XVII-XVIII 7-9. Anal XVII-XX 11-13. 27 to 29 scales in a longitudinal series .....	2. <i>sota</i> .

II. Anal fin densely scaly, the scales covering the fin to the tips of the posterior spines.

Dorsal XV-XVIII 8-10. Anal XVI-XVIII 17-20. 29 to 31 scales in a longitudinal series .....	3. <i>labiosus</i> .
Dorsal XV-XVII 7-10. Anal XVII-XVIII 13-17. 27 or 28 scales in a longitudinal series .....	4. <i>lalius</i> .
Dorsal XVII-XIX 6-7. Anal XXI-XXII 13. 28 or 29 scales in a longitudinal series .....	5. <i>chuna</i> .

## 1. TRICHOGASTER FASCIATUS.

*Trichogaster fasciatus* Schneid. Bloch's Syst. Ichth. p. 164, pl. xxxvi. (1801); Günth. Cat. Fish. iii. p. 387 (1861); Day, Fish. India, p. 374, pl. lxxviii. fig. 6 (1878).

*Trichopodus colisa* Buch. Ham. Fish. Ganges, pp. 117, 372, pl. xv. fig. 40 (1822).

*Trichopodus bejeus* Buch. Ham. t. c. pp. 118, 372.

*Trichopodus cotra* Buch. Ham. t. c. pp. 119, 372.

*Colisa vulgaris* Cuv. & Val. Hist. Nat. Poiss. vii. p. 362 (1831).

*Colisa bejeus* Cuv. & Val. t. c. p. 365.

*Colisa cotra* Cuv. & Val. t. c. p. 366.

*Polyacanthus fasciatus* Cuv. & Val. t. c. p. 369.

*Colisa ponticeriana* Cuv. & Val. t. c. p. 370.

29 to 31 scales in a longitudinal series. Dorsal XV–XVII 9–14. Anal XV–XVIII 14–19, scaly at the base. Greenish, with orange or bluish bars descending obliquely downwards and backwards from the back to the anal fin; vertical fins with alternate dark and pale spots or bars; anal often with a red margin.

*Hab.* Northern India, Assam, and Upper Burma.

Numerous specimens, measuring up to 100 mm. in total length.

## 2. TRICHOGASTER SOTA. (Plate LXXIX. fig. 3.)

*Trichopodus sota* Buch. Ham. Fish. Ganges, p. 120 (1822).

*Colisa sota* Cuv. & Val. Hist. Nat. Poiss. vii. p. 367 (1831).

27 to 29 scales in a longitudinal series. Dorsal XVII–XVIII 7–9. Anal XVIII–XX 11–13, scaly at the base. Brownish, sometimes with darker stripes along the series of scales; fins immaculate.

*Hab.* Ganges.

Nine specimens, measuring up to 45 mm. in total length, from Debroo (*Day*).

## 3. TRICHOGASTER LABIOSUS.

*Trichogaster labiosus* Day, Fish. Ind. p. 374, pl. lxxix. fig. 4 (1878).

29 to 31 scales in a longitudinal series. Dorsal XV–XVIII 8–10. Anal XVI–XVIII 17–20, densely scaly, the scales covering the fin to the tips of the posterior spines. Greenish, with some darker somewhat oblique cross-bars on the side; fins immaculate.

*Hab.* Burma, Shan States, and Tenasserim.

Several specimens, measuring up to 90 mm. in total length, from Burma (*Day*), Sittang River (*Oates*) and Tenasserim (*Wood-Mason*).

The thick papillose lips from which the species takes its name occur only in the males; in *T. fasciatus* also the males may have the lips more or less swollen and papillose.

## 4. TRICHOGASTER LALIUS.

*Trichopodus lalius* Ham. Buch. Fish. Ganges, pp. 120, 372 (1822).

*Colisa lalius* Cuv. & Val. Hist. Nat. Poiss. vii. p. 366 (1831).

? *Colisa unicolor* Cuv. & Val. t. c. p. 368.

? *Trichogaster unicolor* Günth. Cat. Fish. iii. p. 388 (1861).

*Trichogaster lalius* Day, Fish. Ind. p. 375, pl. lxxix. fig. 5 (1878).

27 or 28 scales in a longitudinal series. Dorsal XV–XVII



7-10. Anal XVII-XVIII 13-17, densely scaly, the scales covering the fin to the tips of the posterior spines. Body scarlet, crossed by somewhat oblique bands of pale blue; fins with scarlet spots or bars; anal with a red margin.

*Hab.* Northern India and Assam.

Several specimens, measuring up to 50 mm. in total length, from India (*Waterhouse*), Calcutta (*Day*), and Cachar (*Playfair*).

*Colisa unicolor* was described from Calcutta as a uniformly coloured fish with XV 6 dorsal and XIV 12 anal rays. Day examined the types at Paris, and says they appear to belong to *T. lalius*.

#### 5. TRICHOGASTER CHUNA.

*Trichopodus chuna* Ham. Buch. Fish. Ganges, pp. 121, 372 (1822).

*Colisa chuna* Cuv. & Val. Hist. Nat. Poiss. vii. p. 368 (1831).

*Trichogaster chuna* Day, Fish. Ind. p. 373, pl. lxxix. fig. 3 (1878).

28 or 29 scales in a longitudinal series. Dorsal XVIII-XIX 6-7. Anal XXI-XXII 13, densely scaly, the scales covering the fin to the tips of the posterior spines. Greenish; a blackish longitudinal band from the eye to the caudal fin.

*Hab.* N.E. India and Assam.

Two specimens, less than 40 mm. in total length, from Calcutta (*Day*) and from Jerdon's collection.

### EXPLANATION OF THE PLATES.

#### PLATE LXXVII.

- Fig. 1. *Betta rubra*.  
 2. " *macrophthalma*.  
 3. " *akarensis*.  
 4. " *fasciata*.  
 5. *Polyacanthus signatus*.

#### PLATE LXXVIII.

- Fig. 1. *Betta tæniata*.  
 2. " *fusca*.  
 3. " *macrostoma*.  
 4. " *anabatoïdes*.

#### PLATE LXXIX.

- Fig. 1. *Trichopodus pectoralis*.  
 2. " *leeri*.  
 3. *Trichogaster sota*.

## 3. On a Small Collection of Mammals from Egypt.

By J. LEWIS BONHOTE, M.A., F.L.S., F.Z.S.

[Received July 15, 1909.]

The following is an account of a small collection of Mammals brought home from Egypt. It was made up partly of a few skins and skulls which Capt. S. S. Flower had brought together, chiefly those of animals that had died in the Giza Zoological Gardens or had been killed as vermin, partly of animals brought in from the district by natives, whom Capt. Flower had commissioned on my behalf, and lastly of specimens collected by myself. Unless otherwise mentioned the specimens came from near Cairo.

The collection contains some 28 species, of which one (*Dipodillus mariae*) is new to science, in addition to which I have been enabled to resuscitate the name *Procavia burtoni* for the Egyptian Hyrax, which is quite distinct from both the Sudan and Palestine species. An example of *Acomys russatus*, a very rare species, which has hitherto only been found locally in Palestine and Syria, was procured within a short ride of Cairo. The material has also enabled the range of other and commoner species to be extended, e. g. *Gerbillus mackilligini*, *Lepus innesi*.

I must acknowledge my indebtedness to Messrs. Oldfield Thomas, R. C. Wroughton, and K. Andersen, who have given me much help in the working out of the collection, which is now in the British Museum, and lastly to Capt. Flower, who is doing so much for the Zoology of Egypt and without whose kind co-operation this collection would never have been brought together.

ROUSETTUS ÆGYPTIACUS (E. Geoffr.).

*Pteropus ægyptiacus* E. Geoffr. St. Hil. Ann. du Mus. xv. p. 96 (1810).

*Rousettus ægyptiacus* de Wint. in Anders. Zool. Egypt, Mamm. p. 84 (1902).

I found this Fruit-Bat extremely abundant in the Zoological Gardens. They have never been found roosting there in the daytime, but arrive as soon as it is dark and commence feeding on the fig-trees. Later in the year, as other fruits ripen they change their diet. Although most of my specimens were obtained in February and March, the reputed breeding season, none of the females were gravid. Several young about three-quarter grown were shot. The White Owl (*Strix flammea*) occasionally preys largely on these bats.

RHINOLOPHUS ACROTIS BRACHYGNATHUS K. Anders.

*Rhinolophus acrotis brachygnathus* Anders. Ann. Mag. N. H. ser. 7, vol. xv. p. 73 (1905).

One male from the Giza Gardens.

## NYCTERIS THEBAICA E. Geoffr.

*Nycteris thebaica* E. Geoffr. St. Hil. Ann. du Mus. xx. p. 20, pl. i. (1813); de Wint. in Anders. Zool. Egypt, Mamm. p. 107 (1902).

A single specimen of this species was obtained in the Fayum.

## PIPISTRELLUS KUHLLI (Natt.).

*Vespertilio kuhlii* Natt., in Kuhl, Deutsch. Flederm., Wetterau Ann. iv. p. 55 (1817).

*Pipistrellus kuhlii* Natt., de Wint. in Anders. Zool. Egypt, Mamm. p. 124 (1902).

A common species near Giza, also obtained in the Fayum.

## PIPISTRELLUS RUEPELLII (Fisch.).

*Vespertilio rüppellii* Fischer, Syn. Mamm. p. 109 (1829).

*Pipistrellus rueppelli* Fisch., de Wint. in Anders. Zool. Egypt, Mamm. p. 127 (1902).

A single example obtained in the Fayum.

## RHINOPOMA MICROPHYLLUM (Brünn.).

*Vespertilio microphyllum* Brünnich, Dyrenes Hist. og Dyresam. Universit. Natur-Theater, i. p. 50, pl. vi. figs. 1-4 (1782).

*Rhinopoma microphyllum* (Brünn.), de Wint. in Anders. Zool. Egypt, Mamm. p. 143 (1902).

Of the two specimens of *Rhinopoma* from Aburoash, one proved to belong to this species. Except for skull characters and length of forearm this and the following species seem to be identical, and to live side by side in the same caves.

## RHINOPOMA CYSTOPS Thos.

*Rhinopoma cystops* Thos. Ann. Mag. N. H. ser. 7, vol. xi. p. 497 (1903).

In visiting a cave at Aburoash in which Capt. Flower had told me that bats of this genus were abundant, I was surprised at seeing only about half-a-dozen specimens, of which I secured two examples. Possibly these bats were hibernating in the cracks and fissures, as I was unable to procure some owing to their running into clefts. These bats are able to crawl about easily and with considerable alertness (for a bat) on the sides and roof of the cave. In all the examples procured there was no sign of any accumulation of fat on the tail and thighs. Thinking that the scarcity of these bats was due to hibernation, I again visited the cave about a month later on the 3rd of April, and then only saw three individuals, but possibly I was still too early.

## NYCTINOMUS TÆNIOTIS (Rafinesque).

*Cephalotes tæniotis* Rafinesque, Précis découv. somiol. p. 12 (1814)=*N. cestonii* (Savi).

One example from Aburoash.

*CROCIDURA (Crocidura) OLIVIERI (Less.).**Sorex olivieri* Lesson, Man. Mamm. p. 121 (1827).*Crocidura olivieri* (Less.), de Wint. in Anders. Zool. Egypt, Mamm. p. 166 (1902).

I brought back two specimens from Giza, collected by Mr. M. J. Nicoll. The male is slightly greyer in colour than the female. The dimensions (in the flesh) were as follows:—

♂. 22. 9.08. Head and body 107 mm., tail 69, hindft. 21, ear 10.  
 ♀. 12.12.06. „ 110 mm., tail 65, hindft. 16, ear 4.

*CROCIDURA (Crocidura) RELIGIOSA* Is. Geoffr.*Sorex religiosa* Is. Geoffr. Mém. Mus. xv. p. 128, pl. iv. fig. 1 (1827).*Crocidura religiosus* (Is. Geoffr.), de Wint. in Anders. Zool. Egypt, Mamm. p. 168 (1902).

Through the kindness of Capt. Flower I was able to bring back a spirit specimen of this rare and little known species, which had been taken alive at Giza.

*FELIS CHAUS NILOTICA* de Wint.*Felis chaus nilotica* de Wint. Ann. Mag. Nat. Hist. ser. 7, vol. ii. p. 292 (1898); id. in Anders. Zool. Egypt, Mamm. p. 176 (1902).

The Wild Cat is by no means uncommon at Giza and in the course of the year does considerable damage to the animals and birds in the Gardens. During my stay one killed a nearly full-grown sheep, and after dragging it to the edge of the enclosure, devoured a whole fore-quarter. Capt. Flower gave me the following notes as to their weight. The heaviest known was procured at Benha and weighed 21 pounds. On this estate, where many are destroyed every year, the average weight is said to be 16 pounds. An old male caught in the Gardens during my stay weighed 17·6 pounds. The measurements of this specimen were:—Head and body 725 mm., tail 280, hind-foot 178, ear 70.

The following are skull measurements of this example and of two others.

	Greatest length.	Breadth across palate outside pm. 3.	Pm. 2.	Pm. 3.
	mm.	mm.	mm.	mm.
a. Captured wild at Giza, 2.2.09. ♂ .....	134	54	10	15×9
b. At least 6 years old, died in capt., 13.5.08. ♂.	140	59	9	—
c. Shot wild at Giza, —.5.07. ♀ .....	120	50	9	11×7·5



*FELIS LYBICA* Meyer.

I never met with this species, but a variety of the domestic cat frequently seen is, at a rough glance, almost exactly like this species.

*VULPES VULPES ÆGYPTIACA* (Sonn.).

*Canis ægyptiacus* Sonnini, Nouv. Dict. vi. p. 524 (1816).

*Vulpes vulpes ægyptiacus* de Wint. in Anders. Zool. Egypt, Mamm. p. 227 (1902).

Foxes were fairly plentiful and occasionally seen by day in the desert bordering the cultivation near Aburoash.

*PUTORIUS AFRICANUS* (Desm.).

*Mustela africana* Desm. Nouv. Dict. Hist. Nat. xix. p. 376 (1818).

*Putorius africanus* (Desm.), de Wint. in Anders. Zool. Egypt, Mamm. p. 235 (1902).

The Stoat is very common in Cairo and the neighbouring villages, where it inhabits houses, preying presumably on the rats. The amount of white on the underparts shows much variation, but the chin and throat are nearly always white although broken up with patches of brown. Along the rest of the body there is frequently only a narrow median line of white which broadens out on the inner sides of the thighs.

*GERBILLUS PYRAMIDUM* Geoffr.

*Gerbillus pyramidum* Is. Geoffr. Dict. Class. N. H. vii. p. 321 (1825); de Wint. in Anders. Zool. Egypt, Mamm. p. 255 (1902).

Two specimens of this species were brought in by local Bedouins. They show considerable variation in colour though the measurements are alike. One is of a pale buff with the dark tips to the hairs largely predominating, the other is much more rufous and the dark tips are minute and hardly affect the general colour. The British Museum collection contains several examples intermediate between these two.

*GERBILLUS TARABULI* Thos.

*Gerbillus pyramidum tarabuli* Thos. P. Z. S. 1902, p. 5.

*Gerbillus tarabuli* Thos., Schwann, Nov. Zool. xii. p. 3 (1905).

Mr. Thomas in his original description has regarded this species as a form of *G. pyramidum*, but as we find it now in company with this species, I am inclined to regard it as a form of *G. pygargus*, to which also it approximates in general appearance. Our knowledge of these forms is, however, still so limited that, for the present, it seems best to adhere to binomial classification.

I brought back four skins as well as several living examples, and for the present have followed Mr. Schwann in assigning them to

the above species. My specimens agree very well with those brought back by Mr. Rothschild from the Wadi Natron, but seem to differ slightly from the typical series from Tripoli. In the subsequent working out of this race note should be taken of *G. burtoni* (F. Cuv. Trans. Zool. Soc. ii. p. 145, 1838), which Lataste has placed as a synonym of *G. pygargus*. The material at my disposal is at present too scanty to allow of a decided opinion, but I am inclined to the belief that *pygargus*, *burtoni*, and *tarabuli* will prove to be forms of one and the same species.

GERBILLUS PYGARGUS F. Cuv.

*Gerbillus pygargus* F. Cuv. Trans. Zool. Soc. ii. p. 142, pl. 25. figs. 10-14 (1838); de Wint. in Anders., Zool. Egypt, Mamm. p. 256 (1902).

One specimen brought home from No. 5 Station on the Sudan Railway by Capt. Flower.

GERBILLUS GERBILLUS (Oliv.).

*Dipus gerbillus* Olivier, Bull. des Sc. Phil. Paris, ii. p. 121 (1801).

*Gerbillus gerbillus* (Oliv.), de Wint. in Anders. Zool. Egypt, Mamm., p. 252 (1902).

This pretty little Gerbille, which may at once be distinguished by its bright reddish colour, seems to be very common near Cairo. I have a specimen collected by Capt. Flower in the Sudan which does not differ much from typical Cairo examples.

DIPODILLUS WATERSI de Wint.

*Dipodillus watersi* de Wint. Nov. Zool. viii. 4, p. 399, pl. xx. (1901); id. in Anders. Zool. Egypt, Mamm. p. 263 (1902).

Two examples of this species were brought back by Capt. Flower from Atbara, Sudan.

DIPODILLUS MACKILLIGINI Thos.

*Dipodillus mackilligini* Thos. Ann. Mag. N. H. ser. 7, vol. xiv. p. 158 (1904).

A single specimen of a Gerbille closely resembling this species was brought in from near Cairo. The type locality is on the Sudan frontier many miles to the south.

DIPODILLUS MARLE, sp. n.

While working a tract of country for further specimens of *Acomys russatus*, we caught two specimens of a small species of *Dipodillus* which is apparently undescribed. I have pleasure in naming this species after my wife, who has accompanied me on all my excursions and to whose keen eyesight I owe many of my captures.

Mostly nearly allied to *D. henleyi* but rather larger and much greyer in general tone of coloration.

Colour above yellowish buff, the hairs being slate-coloured at their bases and with blackish tips. On the flanks the hairs are white to their bases. The underparts, feet, sides of the face, a spot above and behind each eye and behind each ear white.

The *skull* differs from that of *henleyi* in the larger size of the bullæ and teeth, though the skull itself is but very little larger. The bullæ in size approximate to those of *D. amœnus*, a much larger species.

Measurements of type (in flesh):—Head and body 60 mm.; tail 87; hind-foot 18; ear 8.

*Skull*. Greatest length 21·5 mm.; basal length 19; greatest breadth 12; length of palate from henselion 2; diastema 5; greatest length of bullæ 7; length of molar series 2·7.

*Type*. Coll. J. L. B. No. 288. Ad. Mokattam Hills near Cairo, 25th March, 1909.

One of the two specimens obtained was kept alive to ensure it being full grown, but it unfortunately escaped.

#### MERIONES CRASSUS Sundevall.

*Meriones crassus* Sundev. K. Vet.-Ak. Handl. p. 233, pl. 11. fig. 4 (cranium) (1843).

*Meriones crassus selysii* Pomel, H. Schwann, Nov. Zool. xii. p. 3 (1905).

Four skins of a *Meriones* were brought back, two from Atbarā, Sudan, where they were procured by Capt. Flower, and kept alive in the Giza Gardens, and two that were brought in alive by natives. It is impossible on this material, even combined with that at the British Museum, to work out this very difficult group. As they have large bullæ I have provisionally placed them under Sundevall's name, as the type of *crassus* came from Sinai. Those from the Sudan appear to be rather larger and greyer in colour, and have in life a rather more pointed snout.

#### PSAMMOMYS OBESES Cretzschm.

*Psammomys obesus* Cretzschm., Rüpp. Atlas, p. 58, pl. 22 (1828); de Wint. in Anders. Zool. Egypt, Mamm. p. 270 (1902).

A single example of this form was given me by Dr. Todd, of the Public Health Department. It belongs to the typical form, and came from Abu Homos in the Delta near Alexandria.

#### MUS RATTUS Linn.

*Mus rattus* Linn. Syst. Nat. x. p. 61 (1758); de Wint. in Anders. Zool. Egypt, Mamm. p. 274 (1902).

*Mus alexandrinus* Desm. Nouv. Dict. Hist. Nat. xxix. p. 47 (1819).

*Mus tectorum* Savi, Nov. Giorn. Pisa, Feb. 1825.

A very abundant species throughout the country.

Two forms of this species occur :—

- a. *Mus rattus tectorum*,  
in which the fur of the underparts is white to its base.  
Average hind-foot measurement 35 mm.
- b. *Mus rattus alexandrinus*,  
in which the fur of the underparts is wholly or partially  
slate-coloured. Average hind-foot measurement 33 mm.

I made a considerable study of the variations of this species, the results of which I am now working out and hope to publish in a separate paper.

#### MUS NORVEGICUS Erxl.

*Mus norvegicus* Erxl. Syst. Reg. Anim. p. 381 (1777); de Wint. in Anders. Zool. Egypt, Mamm. p. 276 (1902).

This rat is now becoming very common in some districts though at present its distribution seems rather erratic. It is said not to occur in Cairo itself, though on the other (western) side of the Nile it is very numerous. Capt. Flower tells me that it has been found in the Zoological Gardens only within the last eight years, and in that time it has completely ousted *Arvicanthis* which used formerly to abound there, and quite fifty per cent. of the "rats" caught in the Gardens now belong to this species. I procured two specimens in the Fayum.

#### MUS MUSCULUS Linn.

*Mus gentilis* Brants, Muizen, p. 126 (1827).

*Mus orientalis* Cretzschmar, Rüpp. Atlas, p. 76, pl. 30 (1828).

*Mus musculus* Linn. Syst. Nat. x. p. 62 (1758); de Wint. in Anders. Zool. Egypt, Mamm. p. 277 (1902).

Two forms of this species are apparently found in the Giza Gardens. One form may, I think, be known as *Mus m. gentilis* (Brants), in which the hairs of the under parts are white to their bases and the whole animal is of a more fulvous tint.

The other is *Mus m. orientalis* Cretzschm. In this form the hairs of the under parts have slate-coloured bases. The general colour is greyer than in *Mus m. gentilis*, and a clear line of fawn along each side separates the colour of the upper from that of the under parts.

#### ARVICANTHIS NILOTICUS (Desm.).

*Arvicola niloticus* Desmarest, Ency. Méthod., Mamm. Suppl. p. 281 (1822).

*Arvicanthis niloticus* (Desm.) de Wint. in Anders. Zool. Egypt, Mamm. p. 279 (1902).

This species is extremely common throughout the country. It lives almost entirely in the open fields except during the



inundation, when it is forced to take refuge in the villages. Some specimens procured on the southern shores of Lake Mœris in the Fayum were indistinguishable from Cairo examples.

*ACOMYS CAHIRINUS* (Desm.).

*Mus cahirinus* Desm. Nouv. Dict. Hist. Nat. xxix. p. 70 (1819).

*Acomys cahirinus* de Wint. in Anders. Zool. Egypt, Mamm. p. 282 (1902).

This is the common House Mouse of Cairo, far outnumbering *Mus musculus*. A large series (86) was examined: they prove very constant in coloration, and with the exception of the fingers and toes they are of a uniform slaty blue all over. Slight traces of white are sometimes visible on the breast and along the median line. The sexes are alike in size and the average is:—Head and body 101 mm.; tail 105; hind-foot 18; ear 17. The largest individual (a male) measured:—Head and body 109 mm.; tail 119; hind-foot 19; ear 19.

*ACOMYS RUSSATUS* Wagn.

*Acomys russatus* Wagner, Abh. Akad. Munich, iii. p. 195, pl. 3. fig. 2 (1840); Tristram, Fauna Palestine, p. 11, pl. 3. fig. 1 (1884).

I procured a single example of this species within half an hour's ride of the Citadel on the Mokattam Hills, and it seems certainly strange that it should not previously have been recorded from Egypt.

It is an extremely well-marked species, and may easily be distinguished by the hairiness of the ears on both their inner and exterior surfaces and by the colour of the under parts being of a greyish white with no sharp line of demarcation from the colour of the upper parts. In all other species of *Acomys* the ears are naked and the under parts (except in *A. cahirinus*) are snowy white divided sharply from the colour of the upper parts.

The colour of the upper parts is a uniform reddish fawn, the brown tips to each spine being so minute as not in any way to affect the general colour. The feet are thickly covered with short spines and the tail is well clothed with stiffish hairs.

The skull differs from that of its allies in having the snout rather shorter and broader, the bullæ considerably larger and thus tending to constrict the basi-occipital and to make it more concave. The most noticeable point, however, is the size of the teeth and the length of the molar series, which latter measures 5 mm. as against 4 mm. in the other species. *A. nesiotis* Bate has a molar series of 4.5 mm. and in this measurement comes nearest to the present one, but the whole animal is larger, so that the increase in size of the teeth is merely in proportion to the general increase in the size of the animal. In other respects the skull of *nesiotis* agrees with that of *dimidiatus*.

For many details of this group I am indebted to Mr. R. C.

Wroughton, who kindly allowed me to look over MS. notes of his on the genus.

The measurements of my specimen, an adult female, are :—Head and body 97 mm.; tail imperf. 60 (certainly *shorter* than head and body when complete); hind-foot 18; ear 16·5.

*Skull.* Greatest length 29 mm.; basal length 24; greatest breadth 15; length of molar series 5; length of diastema 7; length of palate to hensenion 23; length of nasals 11·5.

This is apparently a very scarce and local species. The type locality is Sinai, and Tristram found it near Massada at the southern end of the Dead Sea but not elsewhere in Palestine, and since then it does not seem to have been brought home by any collector. There is a specimen of Burton's in the Museum which has been referred to this species, but it is in such a bad state that identification is quite impossible.

It is certainly curious that this species, occurring so near Cairo, should never have been brought in by local Bedouins, but the fact that a second visit to the locality with two men to dig did not result in any further examples of this species, but brought to light two individuals of the new *Dipodillus* described in this paper, tends to show that the particular locality is certainly unworked either by natives or collectors and that such mammals may escape observation even when searched for\*.

JACULUS JACULUS (L.).

*Mus jaculus* Linn. Syst. Nat. x. p. 63 (1758).

*Jaculus jaculus* (Linn.), de Wint. in Anders. Zool. Egypt, Mamm. p. 305 (1902).

This species is frequently brought in from the desert near Cairo. It is smaller and yellower in general coloration than the next species.

JACULUS JACULUS GORDONI Thos.

*Jaculus gordonii* Thos. P. Z. S. 1903, p. 299.

The southern form of this species seems paler and rather larger than the typical race from Egypt. A single specimen from Khartoum, the type locality, was brought back.

LEPUS INNESI de Wint.

*Lepus innesi* de Winton, Nov. Zool. ix. p. 445 (1902).

A single example of this Desert Hare was shot by Mr. M. J. Nicoll in the desert near Aburoash. It was originally described from Gattah in the Fayum, so that this record extends its range to the north. One of the most distinctive points of this species is the long white hairs on the flanks and sides of the body.

The measurements of this specimen (a female) were :—Head and

\* Since the above was written Mr. Nicoll informs me that he has procured another example of this species in the Wadi Hof near Helouan.

body 453 mm.; tail 77; hind-foot 96; ear from notch 102, from crown 128; breadth of ear 57.

*PROCAVIA BURTONI* (Gray).

*Hyrax burtoni* Gray, Ann. Mag. Nat. Hist. ser. 4, i. p. 43 (1868).

*Hyrax ruficeps* Thos. P. Z. S. 1892, p. 63; de Wint. in Anders. Zool. Egypt, Mamm. p. 324 (1902).

During my stay in Egypt the Zoological Gardens received, through the kindness of Capt. Burnet Stuart and Mr. Russell, three specimens of a Hyrax from the Wadi Abu Kalifa, east of Sohag, Upper Egypt. These animals lived only a day or two, and on their death were handed over to me by Capt. Flower together with a skull and flat skin collected near the same locality by Mr. Russell the previous autumn.

A careful comparison of these examples with the British Museum collection shows that while they agree with the cotypes of Gray's *H. burtoni*, they are easily distinguishable from specimens occurring in the Sudan and which are undoubtedly referable to *P. ruficeps*.

*P. burtoni* differs from *ruficeps* in having the crown of the head similar in colour to the rest of the upper parts and not markedly darker. The hairs surrounding the dorsal gland are also concolorous with the back, so that the yellow spot so conspicuous in *ruficeps* and some other forms is absent.

*Skull.* Mr. de Winton, referring to Burton's types, notes that they show considerable variation but agree in the length of the molar series. A comparison of a series of eight skulls from the Sudan with the three cotypes of *burtoni*, shows that the teeth in the first mentioned are constantly smaller than in the *burtoni* specimens.

All the examples now brought back, as well as the one from Etbai presented a few years ago by Capt. S. S. Flower, and

Measurements of Skulls.

	Greatest length.	Greatest breadth.	Basal length.	Palate length to hens.	Length of molar series.	Diastema.	Length of nasals.
	mm.	mm.	mm.	mm.	mm.	mm.	mm.
Cotype <i>burtoni</i> . 120 a .....	93	54	...	42	35	11	22.5
" " 120 b ♀ .....	89	52	83	42	35	9	21
" " 120 c ♀ .....	84	52	...	38	36	9	19
Etbai. Capt. Flower .....	85	52	77	40	35	9	20
Wadi Abu Kalifa. Burnet Stuart. } ♀. 6732 B. }	86	50	79	39	35	9	20
" " Burnet Stuart } ♀. 5532 B. }	88	51	80	42	35	10	19
Wadi Fertili. Russell .....	84	50	...	39	35	10	17

mentioned by Mr. de Winton, agree with *burtoni* in having the large teeth as well as in the external characters mentioned above, so that I have no hesitation in separating *burtoni* from *ruficeps*.

*P. syriaca* from Palestine and Sinai also has the large teeth; the series available, however, is too small to allow a comparison between the Egyptian and Palestine species to be made. The latter appear to be darker and more washed with fulvous.

The measurements of an adult female of *burtoni* taken in the flesh are :—Head and body 460 mm. ; hind-foot 72 ; ear 30.

I have since received from Capt. Flower the fresh skin of a specimen of *P. syriaca* from Sinai, which died in the Giza Gardens. It agrees well with skins of *P. syriaca* in the Museum. There is a clear yellow patch round the dorsal gland and a median dorsal stripe of the same colour runs towards the tail. In my opinion, therefore, this species is quite distinct from *P. burtoni*.

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November 23, 1909.

Dr. A. SMITH WOODWARD, F.R.S., Vice-President,  
in the Chair.

The Secretary read the following report on the additions made to the Society's Menagerie during the month of October 1909 :—

The number of registered additions to the Society's Menagerie during the month of October last was 148. Of these 94 were acquired by presentation, 16 by purchase, 16 were received on deposit, 2 in exchange, and 20 were born in the Gardens.

The number of departures during the same period, by deaths and removals, was 161.

Amongst the additions special attention may be directed to :—

A Walrus (*Odobenus rosmarus*), from the Arctic Seas, purchased on October 1st.

A Grey Seal (*Halichoerus grypus*), from the North of Ireland, deposited on October 23rd.

A Brazilian Tapir (*Tapirus terrestris*), born in the Menagerie on October 6th.

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The Secretary read the following letter addressed to him by Prof. William Ridgeway, M.A., D.Sc. :—

In my paper on "The Differentiation of the Three Species of Zebras" in the last volume of the P. Z. S., p. 556, when writing about Ward's Zebra, I mentioned the doubts respecting the provenance of the type specimen presented to Prof. Cossar Ewart, F.R.S., by Mr. Rowland Ward. It was originally said to have been "traded out of Somaliland." But later Prof. Ewart gave me the information that its habitat was



probably the Lombori Hills not far from Naivasha, which I embodied in the Appendix to my 'Origin and Influence of the Thoroughbred Horse,' p. 508. In his paper on this specimen published later (P. Z. S. 1904, vol. ii. p. 181), Prof. Ewart states in his footnote that "It probably inhabits part of the area between the upper reaches of the Tana River and Lake Rudolf."

As it was very important to obtain full information, and, if possible, more specimens of this most interesting animal, I had inquiries made in British East Africa with a view to obtaining, if possible, a skin. My friend, Mr. C. W. Hobley, C.M.G., who has helped me much in such matters, endeavoured to find out the habitat of Ward's Zebra. He was told by Lord Delamere that he had shot near Baringo the animal, the skin of which had been named after Mr. Ward.

Messrs. Ward & Co. have now written to inform me that they most certainly did not acquire the skin from Lord Delamere, but that "the type *E. wardi* was purchased in the flesh from Barnum and Bailey's Menagerie."

Prof. Ewart, in a letter dated 9 Nov. 1909, writes to me as follows:—"About the provenance of 'Ward's Zebra' I am still ignorant. The zebra in question was, I believe, accidentally strangled by Barnum and Bailey's people when they were, for some purpose, putting on a halter. After correspondence with the owners all that Mr. Ward could learn was that, as I originally told you, the zebra was 'traded out of Somaliland.'"

I am of course responsible for any mistake in the matter, and, as I am anxious to have the error corrected as soon as possible, I will be very grateful if you will read this note at the next meeting of the Zoological Society and print it in the Proceedings.

Flendyshe, Fen Ditton,  
Cambridge.  
13 Nov., 1909.

Yours sincerely,

WILLIAM RIDGEWAY.

POSTSCRIPT, 19th Feb., 1910.—My friend Mr. R. I. Pocock, F.Z.S. ('Field,' 20th Nov. 1909, p. 889) suggested that "Ward's Zebra is nothing but a hybrid between a Mountain Zebra (*E. zebra*) and Chapman's Zebra." He substantiated this view in the 'Field' (18th Dec. 1909) by a letter from Dr. Heck, the Director of the Berlin Zoological Garden, who states that he saw a hybrid Zebra resembling Ward's Zebra in Hagenbeck's Menagerie in 1902. He adds an extract from a letter from Mr. Hagenbeck, who speaks of this Zebra as a hybrid between *Equus zebra* and *Equus chapmani* that came from the Jardin des Plantes in Paris. "The photograph of this specimen," says Mr. Pocock, "taken by Hagenbeck and also kindly submitted to me by Dr. Heck, represents an animal differing in no important particulars from Ward's Zebra. It is therefore highly probable that Messrs. Barnum and Bailey procured Ward's Zebra from the Jardin des Plantes."

Mr. Pocock seems to have got the real provenance. If from the outset it had been stated that it was procured from Barnum and Bailey's, much unnecessary propagation of error would have been avoided. This story shows the immense importance of getting specimens direct from Africa, as is the case with the series of skins figured in my paper.—W. R.

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Dr. F. D. Welch, F.Z.S., exhibited photographs of a male Gayal (*Bibos frontalis*) living in the Society's Gardens, in which the lower halves of both fore and hind legs were almost entirely black instead of pure white as in the normal adult.

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#### BRITISH NESTING TERNS.

Mr. William Bickerton, F.Z.S., M.B.O.U., gave a lecture illustrated with about 120 lantern-slides showing the nesting haunts and habits of the five species of Terns which nested in the British Islands. These, given in the order in which they arrive during the Spring migration, are:—Sandwich Tern (*Sterna cantiaca*), end of March; Common Tern (*S. fluviatilis*) and Arctic Tern (*S. macrura*), latter part of April; Roseate Tern (*S. dougalli*), very end of April; Little Tern (*S. minuta*), early in May. He contributed the following notes on these Terns, arranged in the order in which the birds were photographed—Sandwich Tern, Common Tern, Little Tern, Roseate Tern, Arctic Tern. The three first-named he had photographed in a haunt where they all nested in the same locality, namely an area of sand-hills on the coast at Ravenglass in Cumberland.

Sandwich Tern (*Sterna cantiaca*).—This is the earliest to arrive in spring, and the first to nest. The Sandwich Terns at Ravenglass did not all nest in one area, but chose four or five different areas in different portions of the Sand-hills District. Some of these nesting areas were on quite bare sand; others amongst the long marram grass, and others in intermediate areas partly sandy and partly grass-covered. They are probably the most social of all the five species in that the nests are more concentrated in any particular nesting area. The eggs were always either one or two in number. On no occasion were three eggs found in any one nest, although the colonies were visited in three successive nesting-seasons—1905, 1906, and 1907. The young birds began to hatch out during the last week in May. The Sandwich Tern is the most insanitary of all the five species, inasmuch as the droppings of the birds always seemed to be deposited immediately round the outside of the nest—a point that had not been noticed with regard to any other species. In fact the condition of the surroundings of the nest was, roughly speaking, a test of the length of time that had elapsed since incubation commenced.

Common Tern (*Sterna fluviatilis*).—This was the latest of the three species to nest at Ravenglass—very few eggs being found before the end of the first week in June, at which date large numbers of the Sandwich Terns were hatched out. He had been on the nesting area as late as July 7th and failed to find a single young bird hatched out. At that time the Sandwich Terns had absolutely completed their nesting season. There were probably 1000 to 1500 pairs of Common Terns nesting, and the following

result was noted in a casual walk across their nesting area on July 2nd, 1907:—

				Total.
102	nests	contained	1 egg each	= 102 eggs
121	"	"	2 eggs "	= 242 "
9	"	"	3 " "	= 27 "
<u>232</u>	nests		contained	<u>371</u> eggs

He had observed very considerable variation in the position and surroundings of the nests. Some of these were made in long grass; some in short grass; others on quite bare sand, and others on a bank of shingle. The materials of the nests also showed great variation, but generally speaking it was the exception to find a bulky nest of this species. The large majority were simply holes scratched in the sand or grass without either structural or lining material. He had noticed very considerable variation in the colour of the eggs, and this applied both to the ground-colour and markings. As a rule the ground-colour was much duller than that of either the Sandwich or the Little Tern.

Lesser or Little Tern (*Sterna minuta*).—This was the least numerous of all in the locality named—the colony including not more than about half a dozen pairs. The Lesser Terns were generally less social in their habits than any of the others. They also nested further apart, and he never found it possible to include two nests in the same half-plate photograph. Moreover, the Little Terns always seemed to choose a nesting area quite near to the sea, or river estuary, and for the most part on a sand-bank only just above high-water mark. The white crescentic band on the forehead characteristic of this species was clearly shown in the photographs. Most of the Lesser Terns seemed to use small stones and broken fragments of shell as nest material, and in this respect they were quite characteristic.

Roseate Tern (*Sterna dougalli*).—The series of photographs of these birds shown by the Lecturer were unique, being the only series ever taken within the British Isles. He did not give the locality in which the photographs were obtained, as he wished to do what was possible to protect this rarest and perhaps most beautiful species of the group. Roughly speaking there were in the nesting area referred to about 10,000 pairs of Arctic Terns and 1000 pairs of Common Terns. So far as he could judge, there were not more than from fifteen to twenty pairs of Roseates, and of these he managed to find eight distinct and clearly identified nests, each of which contained only one egg. From the field naturalist's point of view there were four marks of distinction of the Roseate Tern, viz., the roseate colour of the breast, the black bill reddish just at the base, the harsh cry "errark-errark," and the long streamers of the tail. He cited Mr. H. E. Dresser's statement that "the wing of this species was nine inches in length and the tail nine inches in length, and that the lateral feathers of the tail extended nearly six inches beyond the central ones."

He had found that the Roseate Terns seemed to prefer

association with the Common rather than with the Arctic Terns although individually the pairs of Roseate Terns seemed to select more isolated and somewhat concealed nesting sites than any other species. Four of the eggs found he had carefully measured and found the largest to be  $1\frac{17}{30}$  inches long and the smallest  $1\frac{3}{30}$ . On July 3rd, 1908, the last day of his visit, none of the Roseate Terns or Common Terns in this area had hatched out, but quite a number of young Arctic Terns were found in the nests, some of which were photographed. He found it rather difficult to understand the statement of Dr. Louis Bureau with regard to the date of departure of this species (see report of the Ornithological Congress held in London 1905):—

“The Roseate Tern arrived on the coast (of France) about the 15th of May, commenced nesting about the 5th of June, and departed on the 10th of July approximately.”

He hardly thought it possible for the young Roseate Terns to leave their nesting islands within say a fortnight of being hatched, and if Dr. Bureau's statement were to be accepted, it could only mean that the old birds departed, leaving their nestlings in an almost helpless condition.

Arctic Tern (*Sterna macrura*).—He estimated that there were 10,000 pairs of this species on the nesting area, which was probably one of the largest colonies in the British Isles. They evinced a marked preference for nesting just where the grassy portions of the island intermingled with ridges and areas of bare rock. For instance, he had marked out an area roughly rectangular in form, 140 yards long by 30 yards across. On each of the long sides of this area a ridge of bare rocks protruded through the grass, and walking along each of these two rocky ridges and finally walking down the central line of the grassy area, he had noticed nests of the Arctic Terns as follows:—

Along Eastern rock ridge	82 nests with 133 eggs.
„ Western „ „	93 „ „ 160 „
Total	<u>175</u> <u>293</u>

Along the central line of the grassy area there were 34 nests with 62 eggs.

Again he had found extraordinary differences both in the sites chosen for nests and in the materials of which the nests were made, and a type series of such nesting sites and materials was well shown in the photographs. A series of very beautiful slides showing the Arctic Terns alighting at their nests with extended wings was also shown. He had noticed that the Arctic Terns were not only more vocal, but bolder and more vicious than any of the other species. They would not only swoop at a passer-by but would in many instances actually strike him as well. He had noticed that both sexes shared in the duties of incubation. The first young bird was hatched out on June 29th and on July 1st he counted thirteen young ones, although this number was by no means exhaustive.



The following papers were read :—

1. An Account of the Geographical Distribution of the Marsupials and Monotremes of South-West Australia, having special reference to the specimens collected during the Balston Expedition of 1904-1907. By G. C. SHORTRIDGE \*.

[Received May 7, 1909.]

(Text-figures 244-277.)

*List of Western Australian Marsupials and Monotremes  
South of the Tropics.*

- MACROPUS GIGANTEUS Zimm. S.W.  
 " ROBUSTUS CERVINUS Thos. N.W. C.  
 [ " *robustus erubescens* † Sclat. S.E.]  
 " RUFUS Desm. N.W. C. S.E.  
 " IRMA Jourd. S.W.  
 " EUGENII Desm. S.W.  
 " BRACHYURUS Quoy & Gaim. S.W.  
 PETROGALE LATERALIS Gld. S.W. (N.W.?)  
 " LATERALIS HACKETTI Thos. S.W. (insular).  
 ONYCHOGALE LUNATA Gld. S.W.  
 LAGOSTROPHUS FASCIATUS Pér & Les. N.W. (insular).  
 " FASCIATUS ALBIPILIS Gld. S.W.  
 LAGORCHESTES HIRSUTUS Gld. S.W.  
 " HIRSUTUS BERNIERI Thos. N.W. (insular).  
 " HIRSUTUS DORRÆ Thos. N.W. (insular).  
 BETTONGIA PENICILLATA Gray. S.W.  
 " LESUEURI Quoy & Gaim. N.W. (insular).  
 " LESUEURI GRAYI Gld. S.W.  
 POTOROUS GILBERTI Gld. S.W.  
 " PLATYTOPS Gld. S.W.  
 TARSIPES SPENSERÆ Gray. S.W.  
 DROMICIA CONGINNA Gld. S.W. C.  
 PSEUDOCHIRUS OCCIDENTALIS Thos. S.W.  
 TRICHOSURUS VULPECULA Kerr. S.W. (C., a rare straggler.)  
 [Phascolomys sp.†?] S.E.?  
 THALACOMYS LAGOTIS Reid. S.W. N.W. C.  
 ISOODON OESULUS Shaw. S.W.  
 PERAMELES BOUGAINVILLEI Quoy & Gaim. N.W. (insular).  
 " BOUGAINVILLEI MYOSUROS Wagn. S.W.  
 [Chacropus castanotis † Gray.] (S.W.?) (N.W.?)  
 DASYURUS GEOFFROYI FORTIS Thos. S.W.  
 PHASCOGALE FLAVIPES LEUCOGASTER Gray. S.W.  
 " CALURA Gld. S.W.

\* Communicated by Mr. OLDFIELD THOMAS, F.R.S., F.Z.S.

† Occurrence in South-Western Australia not yet confirmed.

PHASCOGALE PENICILLATA Shaw. S.W. (C?)

“ APICALIS Gray.

[*blighi*\* Woodward ?] ? N.W.? C.?

SMINTHOPSIS MURINA Waterh. S.W.

CRASSICAUDATA Gld. S.W. N.W. C.

[*Antechinomys spenceri* Thos.] ? C.?

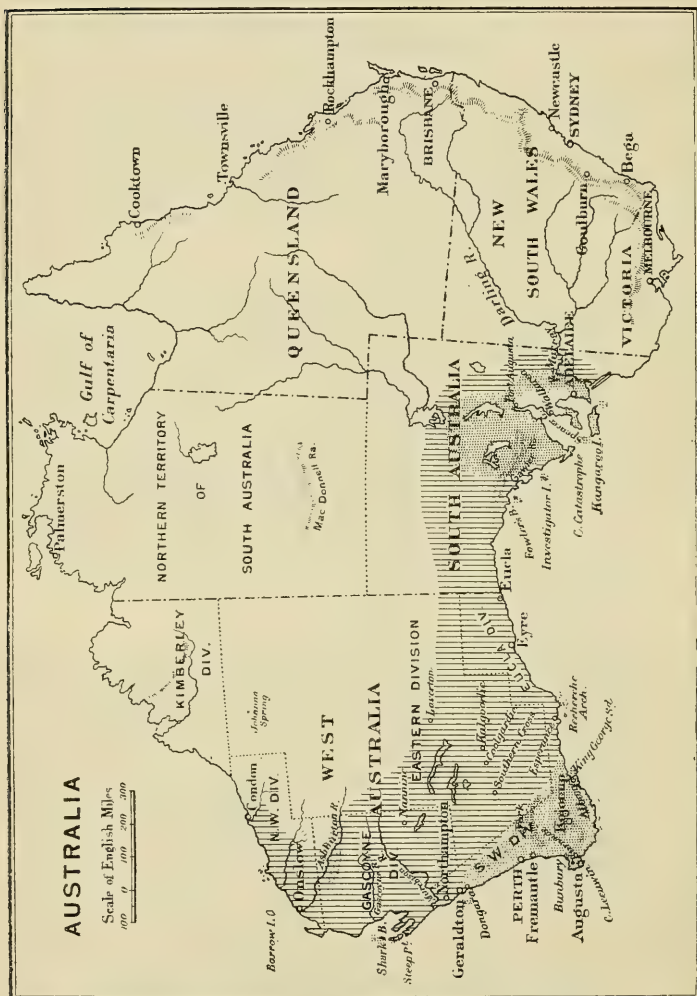
MYRMECOBIUS FASCIATUS Waterh. S.W.

[*Notoryctes typhlops*\* Stirling.] ? C ? S.E.?

TACHYGLOSSUS ACULEATUS INEPTUS Thos. S.W. C. N.W.

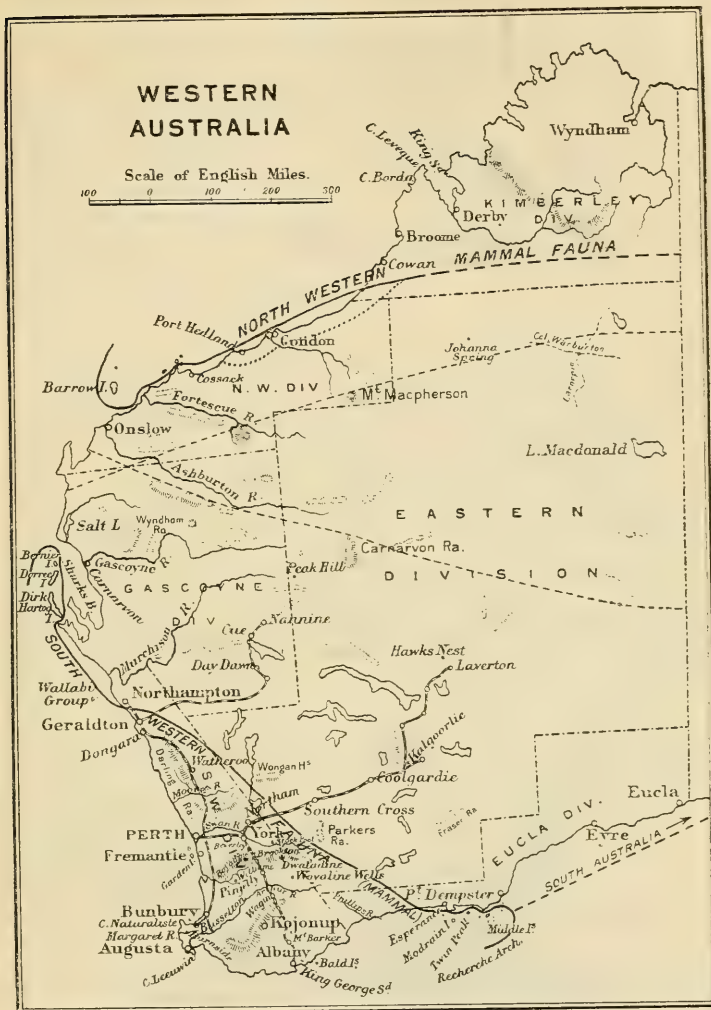
\* Occurrence in South-Western Australia not yet confirmed.

Text-fig. 244.



Map showing present range (dotted area) and probable former range (vertical lines) of West Australian mammalian fauna.

Text-fig. 245.



Map showing Mammalian Faunistic regions of Western Australia.

*MACROPUS GIGANTEUS* Zimm. (Text-fig. 246, p. 806.)

Confined to the South-Western districts: plentiful except in the neighbourhood of towns—being replaced in the North-West, Central, and South-East by *Macropus rufus*—extending along the coast as far north as Geraldton, inland from which town, however, the Red Kangaroo is said to be the more plentiful species.

Not occurring beyond, if as far, as Esperance in the South-East, where it is again replaced by the Red.

Text-fig. 246 \*.



Map showing distribution of *Macropus giganteus*.

As with most of the species common to both States, the area in which it occurs in the West is separated from that in South

\* On this and following maps the dotted area indicates ascertained present range, horizontal lines—probable range, vertical lines—extinct, and crossed lines—dying out.



Australia by a wide tract of dry desert country from six to eight hundred miles in width.

In the extreme South-Western coastal districts there appears to be a somewhat darker race, which is particularly noticeable in immature individuals,—the head, limbs and tail being frequently almost entirely black, possibly corresponding with *Macropus giganteus melanops* of Eastern Australia.

19 specimens collected. Albany (King River); Beverley (Stock Pool); Brookton (Dwaladine); Pinjelly (Woyaline Wells); Margaret River (Burnside) (caves).

Grey Kangaroo (♂ 'Boomer') of Colonists.

'Eonga' ♂, 'Woyre' ♀ (S.W.); 'Eowit' (Moore River), of natives.

*MACROPUS ROBUSTUS CERVINUS* Thos. (Text-fig. 247, p. 808.)

Frequenting rocky hills and mountain ranges in North-Western and parts of Central West Australia, extending south to Southern Cross and inland as far as Laverton, in which places, however, it seems to be less abundant.

Most plentiful towards the North-West, where in favourable situations it extends to the coast. Said to occur as far north as Port Hedland.

Known to colonists as the 'Hill Kangaroo,' to distinguish it from the 'Red' or 'Plain Kangaroo.'

3 specimens collected. Gascoyne River (Wyndham Range) (Clifton Downs station).

'Bigodar' (N.W.), 'Euro' (C.), of natives.

*MACROPUS ROBUSTUS ERUBESCENS* Sclat. (Text-fig. 248, p. 809.)

Of South Australia, is said to occur in the extreme South-East of Western Australia to the east of the Fraser Range.

*MACROPUS RUFUS* Desm. (Text-fig. 249, p. 810.)

Distributed throughout the North-West, Centre, and South-East.

Not occurring in the South-West, where *Macropus giganteus* takes its place, as it does in the southern districts of South Australia, the two species rarely, if ever, frequenting the same areas.

Particularly abundant in the North-West.

The Red and Hill Kangaroos (*M. robustus cervinus*) seem to be less dependent on fresh water than the Grey, although in dry seasons they will collect around pools and 'gnamma holes,' or even dig for water in the beds of dry creeks. However, in many places they exist where water is quite unobtainable.

The females, although normally blue, are frequently of the

Text-fig. 247.

Map showing distribution of *Macropus robustus cervinus*.

same sandy-red colour as the males; the males themselves being very rarely, but occasionally, blue.

18 specimens collected. Laverton (Hawksnest); Gascoyne River (Wyndham Range).

Red or Plain Kangaroo of Colonists.

‘Marlo’ (N.W.) of natives.

Text-fig. 248.



Map showing distribution of *Macropus robustus erubescens*.

MACROPUS IRMA Jourd. (Text-fig. 250, p. 811.)

Range almost identical with that of *Macropus giganteus*, except that it does not seem to occur in the southern coastal districts between Cape Naturaliste and the Leeuwin. Resembling the large Kangaroos rather than the smaller Wallabies in habits. Very fast, and quick in its movements when hunted, when it will

turn and double like a hare. Generally considered to be the best sporting animal in Western Australia.

Text-fig. 249.

Map showing distribution of *Macropus rufus*.

Not apparently dying out or disappearing even in the more thickly populated districts to the same extent as the smaller marsupials.



Extending northwards beyond Watheroo, its range probably ends at some point to the south of Geraldton.

Text-fig. 250.

Map showing distribution of *Macropus irma*.

19 specimens collected. Albany (King River); Mt. Barker; Beverley (Boyadine-Dale River) (Stockpool); Brookton (Dwaladine); Pinjelly (Woyadine Wells).

Brush Kangaroo of Colonists.

'Quoyrer' of natives.

## MACRUPUS EUGENII Desm. (Text-fig. 251.)

Very plentiful in many parts of the South-West, but rapidly disappearing in the cultivated districts, especially towards the

Text-fig. 251.

Map showing distribution of *Macropus eugenii*.

northern end of its range. Not occurring in the coastal country between Albany and Cape Leeuwin, although extending to the

coast at the Margaret River and Cape Naturaliste. Said still to exist in isolated patches in the North between the Swan River and Gin-Gin. Also occurring on the Abrolhos (Wallabi Group), Garden, and some of the islands off Esperance. Although not extending on the South Coast much beyond Phillips River, it reappears on the Southern mainland and on islands off South Australia.

The small Wallabies with the exception of *Lagorchestes* are gregarious, frequenting thickets and dense undergrowth.

34 specimens collected. Wagin (Arthur River); Beverley (Boyadine-Dale River) (Stockpool); Brookton (Dwaladine); Pinjelly (Woyaline Wells); Margaret River (Ellensbrook); Twin Peak and Middle Islands, off Esperance (in Perth Museum).

'Tammar' (S.W.), 'Bonnan' (Margaret River), of natives and Colonists.

#### MACROPUS BRACHYURUS Quoy & Gaim. (Text-fig. 252, p. 814.)

Very plentiful among the coastal thickets and swamps of the South-West, not extending inland. Said to occur sparingly as far north as Moore River. Numerous on Rottnest, where *Macropus eugenii* is equally plentiful, but not found on Garden Island. Also occurring on Bald Island to the east of King George's Sound, and on Twin Peak and probably other islands off Esperance.

38 specimens collected. Albany (King River) (Big Grove); Busselton (Yallingup); Margaret River (Burnside); Rottnest and Bald Islands (in Perth Museum).

'Quokka,' 'Bungcup,' of natives.

#### PETROGALE LATERALIS Gld. (Text-fig. 253, p. 815.)

Fairly plentiful on low rocky hills around Beverley and York. Said to occur sparingly in suitable localities, at least as far north as the Wongan Hills. Distribution apparently very local and patchy. Although not found among the Stirling ranges, it is said to reappear on the coastal hills between Phillips River and Esperance, occurring again on the South Coast and some of the islands off South Australia, which last might be referable to *lateralis hacketti*.

I do not think that this species is likely to occur in the extreme north, although a Rock Wallaby described from around Port Hedland, Cossack, and doubtfully from the Murchison River, may be this species.

10 specimens collected. Beverley (near Stockpool) (Boyadine-Dale River).

Rock Wallaby of Colonists.

'Boggile' of natives (S.W.).





Text-fig. 253.

Map showing distribution of *Petrogale lateralis* and *P. l. hacketti*.

## ONYCHOGALE LUNATA Gld. (Text-fig. 254, p. 816.)

Within a more limited area this species seems to have much the same range as *Macropus eugenii*, both forms frequently occurring together, although generally less plentifully—not extending far, if at all, beyond Beverley in the North, or near the coast; its western boundary apparently being the Darling Range.

Also occurring in the southern interior of South Australia, where, however, it is little known and probably rare.

Gregarious, resembling Kangaroo Rats in occasionally hiding or running into hollow logs or burrows when disturbed.

Text-fig. 254.



Map showing distribution of *Onychogale lunata*.

23 specimens collected. Wagin (Arthur River); Pinjelly (Woyyaline Wells).

'Wurrine' or 'Wurrung' of natives and Colonists.

## LAGOSTROPHUS FASCIATUS Pér. &amp; Les. (Text-fig. 255.)

Confined to Dirk Hartog, Dorrée and Bernier Islands, off Sharks Bay.

Text-fig. 255.



Map showing distribution of *Lagostrophus fasciatus* and *L. f. albipilis*.

Observed on Bernier Island to be particularly abundant, where they had bred to such an extent that in times of drought, when food is scarce, a number would probably have to die.

While on the island during a very dry season, I noticed that both this species and *Lagorchestes* were thin and apparently in a very unhealthy condition, while numbers were lying about dead. It may be noted that sheep had been temporarily introduced there, while in the south of Dirk Hartog there is a large sheep station, and the wallabies are said to have entirely left that end of the island.

14 specimens collected. Bernier Island.

*LAGOSTROPHUS FASCIATUS ALBIPILIS* Gld. (Text-fig. 255, p. 817.)

Existing in a few isolated localities to the east of Pinjelly and Wagin, and according to natives the Pellinup and Salt River districts in the neighbourhood of the Stirling ranges.

Plentiful enough in the restricted areas in which they occur, frequenting thick prickly scrub.

22 specimens collected. Pinjelly (Woyaline Wells).

‘Merrnine’ or ‘Munning’ of natives (S.W.).

Up to quite recently—within the last twenty-five or thirty years—from abundant evidence many of the Western Australian mammals had a much wider range than at the present time, their disappearance, which is said to have been first noticed about 1880, being most sudden and unaccountable. Their former existence is still remembered both by natives and old colonists around Port Hedland, Cossack, Carnarvon, Peak Hill, Laverton, Eucla, and many other widely separated localities. The following, and other less easily recognised species, are said to have been very abundant throughout the Western, South-Eastern, and Central districts:—*Lagostrophus fasciatus*, *Lagorchestes hirsutus*, *Bettongia lesueurii*, and *Trichosurus vulpecula* (wherever trees occurred). To which might be added most of the other mammals common to South Australia.

The above areas are now, with a few exceptions, entirely devoid of indigenous mammals. This is said partly to account for the way in which the natives have been disappearing from the Western and Central districts of late years.

In the North-West even the Red Kangaroos were said to have decreased considerably, although they have since been recovering in numbers: while a few Wallabies are said to still exist to the north of the Ashburton River.

*Lagostrophus fasciatus* was recorded from South Australia many years ago by Gould, and although unknown there now, it might easily have extended into that region.

The entire disappearance of so many species, over such large tracts of country, is generally considered to be due to some epidemic or disease, which I have been told appeared to be a kind of marasmus, perhaps brought into the country by introduced mammals. It may be noted, however, that they have died out chiefly in the drier parts of the country, where, except for the introduction of sheep, there has been very little alteration in



the natural conditions. Rabbits, although already very numerous in the Centre and South-East, have not yet found their way to the North-West.

The mammals of the South-West, to about as far north as the Moore River, have not disappeared in the same extraordinary way, although they are rapidly retreating before civilisation, being already very rare to the north of the thickly populated districts around the Swan River, as well as around all the settled-in and agricultural areas. The burning of forests and general clearing of the country, together with constant raids of dogs and domestic cats, are among the chief causes.

On account of isolation from enemies and disease, the abundance of native mammals on the small islands off the coast, compared in most instances with their scarcity, or in many cases non-existence, on the adjoining mainland, is very marked, and forms a key to the original distribution of many of them. Insular forms of South-Western mammals extend as far north as the Sharks Bay Islands in the West; while in the South several occur on the islands off Esperance, reappearing again on the mainland as well as on islands off the coast of South Australia.

The mammals on the islands off Sharks Bay correspond with the originally widely spread "sand-plain fauna" of the South-West; those on the islands farther south resembling the kinds confined to the coastal and forest districts. On the islands to the north of Bernier, the mammals seem to show a similar likeness to those on the extreme northern mainland, while there would seem to be absolutely no mammals peculiar to the North-West, those that do occur being stragglers from the South-West, North, and Centre.

*LAGORCHESTES HIRSUTUS* Gld. (Text-fig. 256, p. 820.)

Mainland form almost, if not entirely, extinct. Said possibly to still occur very sparingly on sand-plains to the east of Beverley and York—where within quite recent times it was fairly plentiful.

A single specimen was recorded from Hastings, near Kojonup, in 1896, by the Perth Museum.

Described as being very swift and to give a distinct sharp whistle when put up, although I did not notice this on Bernier Island.

Whistler of Colonists.

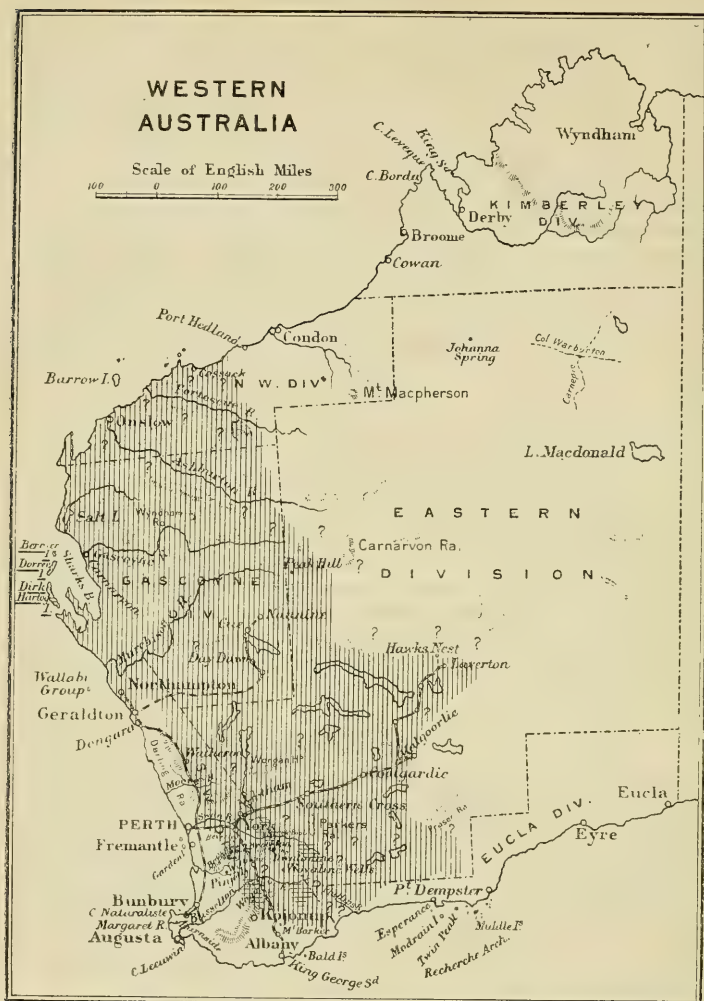
'Wurup' of natives (S.W.).

*LAGORCHESTES HIRSUTUS BERNIERI* Thos. (Text-fig. 256.)

Plentiful on Bernier Island in heathy and spinifex country. Unlike the other small Wallabies *Lagorchestes* is not gregarious, frequenting more or less open country, where it lies up in a form similar to that of a hare, which on Bernier Island is rather deep and generally half hidden beneath a bush or tuft of spinifex.

24 specimens collected. Bernier Island (south end).

Text-fig. 256.



Map showing distribution of *Lagorchestes hirsutus*, *L. h. bernieri*, and *L. h. dorree*.

### LAGORCHESTES HIRSUTUS DORREÆ THOS. (Text-fig. 256.)

Dorée Island. As the red Kangaroo Hares on Bernier and Dorée Islands differ subspecifically, it would be interesting to compare specimens from Dirk Hartog Island.

## BETTONGIA PENICILLATA Gray. (Text-fig. 257.)

Very plentiful in the South-West, where, unlike *Bettongia lesueuri*, it occurs near the coast, extending as far north as the

Text-fig. 257.



Map showing distribution of *Bettongia penicillata*.

Moore River, becoming very rare at its northern limit. Formerly recorded from Sharks Bay, as so many of the other South-Western marsupials have been.

Although getting scarce in the more settled districts, both

species of *Bettongia* are sufficiently numerous in many places to be rather destructive to crops, on which account they are often trapped and poisoned off in large numbers.

Omnivorous, and to a great extent scavengers, often collecting around camps at night in order to pick up any scraps that might be lying about, and, unless specially frightened, they become very fearless, often approaching within a foot or two of where people are sitting. If startled, however, they are wonderfully quick, being even more agile in their movements than the smaller wallabies.

More exclusively nocturnal than the kangaroos and wallabies: lying up by day in a grass nest, which is generally hidden either beneath a thick bush or tuft of grass, and when put up, bolting into the nearest hollow log or patch of cover. Although it has been said that this species carries about bundles of grass or small sticks with its tail, I do not think that such a thing is possible with an animal whose tail is not in the slightest degree prehensile.

Tail occasionally tipped with white like that of "*lesueurii*."

31 specimens collected. Albany (King River); Brookton (Dwaladine); Pinjelly (Woyaline Wells); Busselton (Yallingup); Margaret River (Burnside).

The Kangaroo-rat of Colonists.

'Woylyer' or 'Woyre' of natives.

#### BETTONGIA LESUEURI Quoy & Gaim. (Text-fig. 258.)

Typical form, confined to Bernier, Dorrée, and Dirk Hartog Islands off Sharks Bay, where it is very plentiful, making burrows among the cliffs along the sea-shore. Feeding to a great extent on marine refuse and dead matter, even dead sheep being occasionally partly eaten.

18 specimens collected. Bernier Island.

#### BETTONGIA LESUEURI GRAYI Gld. (Text-fig. 258.)

Very abundant in many parts of the South-West, differing curiously from the insular form in not occurring near the coast. It is possible that some of the mammals that do not occur to the west of the Darling Ranges extend to the coast between Albany and Esperance, and when they existed in the dry districts of the North-West and South-East, there is no doubt that they were coastal there, as this species is still said to be in South Australia. Differing from *Bettongia penicillata*, which it resembles in most of its habits, in being a burrowing animal, numbers often collecting together and making small warrens similar to those of rabbits. The two species of *Bettongia* frequently occur in the same localities.

Not appearing at the present time to exist on the mainland to the north of the Swan River.

Tail very slightly incrassated.

At night the Kangaroo-rats make a peculiar grunting noise as they hop about.







It is quite possible that they are now entirely extinct, although I picked up six old skulls of *Potorous gilberti* near the entrances of some caves in the Margaret River district, and they may still

Text-fig. 260.

Map showing distribution of *Potorous gilberti*.

exist sparingly in that and other localities, as they are very liable to be overlooked on account of their great external resemblance to *Macropus brachyurus*.

The animal known to natives as 'Wurrark' around the Margaret River is probably *Potorous gilberti*, said to frequent marshy country, and although formerly numerous, it is thought to have almost, if not entirely, died out. A few may still occur towards Cape Leeuwin.

A small gregarious wallaby is said to have been at one time plentiful in the coastal scrub to the east of Albany; from the description it was probably one of these species. It was known to the natives as 'Moort,' and according to them has entirely disappeared there. Described as being rather similar to *Macropus brachyurus* in habits, but more sluggish in its movements, on which account cats and bush-fires have probably caused its disappearance.

6 skulls collected (*Potorous gilberti*). Margaret River caves.

TARSIPES SPENSERÆ Gray. (Text-fig. 261.)

As yet known to occur only in the extreme coastal districts of the South-West, although the natives around Beverley speak of a striped marsupial mouse occurring there which they call 'Deed.'

Apparently very local, most of the specimens known having been obtained around Albany; the only other known locality is Wagerup, about thirty miles north of Bunbury, from which place the Perth Museum has a single specimen—described as from the Margaret River. Said to frequent low-lying and often swampy country, making small round grass-nests, like a dormouse, among the thinner branches of Ti-trees or Paper-barks. The small marsupial mice are very difficult to secure on account of their rarity, and their nocturnal, arboreal, and to a great extent insectivorous habits, being chiefly known from cats killing and bringing them into houses.

8 specimens collected (Albany); (6 in Perth Museum).

DROMICIA CONCINNA Gld. (Text-fig. 262, p. 828.)

Rather widely distributed throughout the South-Western and Central districts; obtained as far inland as Parker's Range, near Southern Cross, where it is said to be fairly plentiful, and is well known owing to its frequently dropping down the shafts of mines. A pouched mouse, that probably belongs either to this species or *Sminthopsis crassicaudata*, is also described from Kurrawang (near Kalgoorlie) and Laverton. It occurs in South Australia, where however it seems to be little known.

Arboreal, hiding by day among dead timber, or in nests built either in hollow stumps or among the branches of low trees and bushes.

4 specimens collected. Southern Cross (Parker's Range); Bunbury; Albany (in Perth Museum).

'Possum Mouse of Colonists.

'Nyeranit' (Margaret River) of natives.



Text-fig. 261.

Map showing distribution of *Tarsipes spenserae*.

## PSEUDOCHIRUS OCCIDENTALIS THOS. (Text-fig. 263, p. 829.)

Chiefly confined to the banks of rivers and swamps in the South-West; local, and apparently disappearing in many places.

Fairly plentiful near the Margaret River, where they occur among Ti-trees and peppermint gums, making nests of grass and sticks among the bushes, although occasionally hiding in hollow trees like the Common Opossum.



Ring-tail or Rat-tail Opossum of Colonists.  
 'Wormp' (Beverley), 'Moilyer,' or 'Nguara' (Margaret River), of natives.

Text-fig. 263.

Map showing distribution of *Pseudochirus occidentalis*.

TRICHOSURUS VULPECULA Kert. (Text-fig. 264, p. 830.)

Plentiful and occurring generally throughout the South-West, except in the neighbourhood of towns, although far less abundant and widely distributed than formerly, getting very much thinned

out in many places by trappers. Also it seems to be subject to some epidemic that at times almost clears them out of districts where they were plentiful previously; when this occurs it often takes years for them to recover in numbers.

Text-fig. 264.



Map showing distribution of *Trichosurus vulpecula*.

They appear at one time to have extended over the dry North-Western and Central Districts to as far inland as Laverton,



wherever belts of eucalypti fringed the banks of creeks, but now almost, if not entirely, confined to the south-western corner of the State, a few stragglers only being found as far north as Gin-Gin, and inland.

The red patch on the throat appears only in adult individuals (not visible from the underside of the skin), often becoming more or less suffused over the fur of the whole body with age, and similar to the throat-gland of *Myrmecobius* in being very much less distinct and often entirely absent in the females.

Old males will occasionally take to living in deserted burrows or crevices among rocks, being known to Colonists as Ground Opossums.

Melanism, which is apparently more common in the females, seems to be of far more frequent occurrence in the coastal districts of the extreme South-West, where almost twenty per cent. of the Opossums obtained are black.

Albinos occasionally occur, while specimens with white tail-tips are very common, being in many localities even more plentiful than the normal variety. The black- and white-tailed varieties are said to be very rare in South Australia.

Although not as a rule very active among the branches of trees, when disturbed at night they will generally climb to the topmost branches, evidently with a view of getting as far from danger as possible, rather than of hiding among thick foliage, so that it is easy to discover and shoot them on moonlight nights. They have a distinct and rather peculiar cry which is often heard at night, very much resembling that of the South African Tree-dassie (*Procavia arborea*).

The usual method of trapping 'possums is by fastening a wire snare on a stick placed against a tree on the sloping side by which they invariably descend; as the stick is in a still more slanting position, they leave the tree for the easier means of descent and get caught in the snare.

88 specimens collected. Mt. Barker; Albany (King River); Beverley (Boyadine-Dale River) (Stockpool); Brookton (Dwaledine); Pinjelly (Woyaline Wells); Busselton (Yallingup); Margaret River (Burnside).

Grey or Black 'Possum of Colonists.

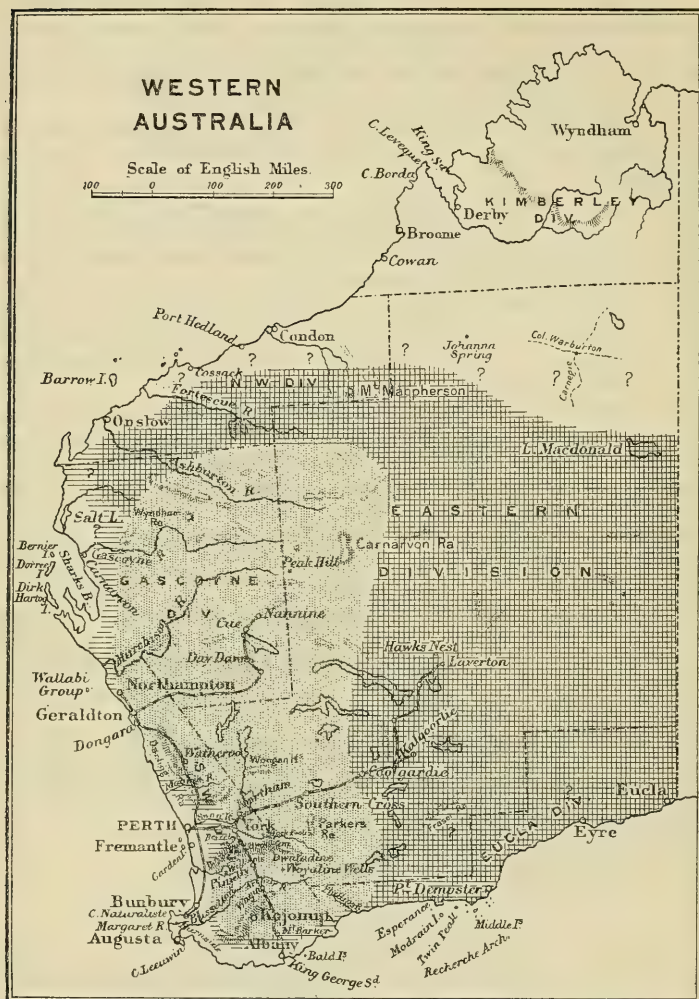
'Koomaal' of natives.

#### THALACOMYS LAGOTIS Reid. (Text-fig. 265, p. 832.)

The only true burrowing marsupial in the South-West with the exception of *Bettongia lesueuri* (the Bandicoots dig pits in the ground in search of roots and insects, but they do not make or live in burrows). *Thalacomys* makes a larger and deeper burrow than *Bettongia*; the entrance also is almost perpendicular for about two feet and then takes a side turn at right angles. Like a badger, it is difficult to dig for, and will often burrow as fast as a man can dig.

As with *Bettongia penicillata*, its tail during life has a peculiar downward curl, although possessing no prehensile power.

Text-fig. 265.

Map showing distribution of *Thalacomys lagotis*.

Nocturnal. Not saltatorial, resembling a rabbit in its movements. Tail tipped with a small sharp pointed horny spur rather like that of *Onychogale*.

Although widely distributed throughout the South-West (except

near the coast), North-West, and Centre, it has within recent years become extremely rare in the far interior. Most plentiful in the inland districts of the South-West, rather frequently caught in traps set for rabbits along the rabbit-proof fence. In the dry North-Western and South-Eastern divisions, where it is rare, it extends to the coast.

Said to be widely distributed in South Australia.

21 specimens collected. Wagin (Arthur River); Southern Cross (Parker's Range); Pinjelly (Woyaline Wells); Watheroo.

Native Rabbit or Pinkie of Colonists.

'Dalgyte' (S.W.), 'Moyer' (N.W.), 'Boodee' (C.), of natives.

*ISOODON OBESULUS* Shaw. (Text-fig. 266, p. 834.)

The Common Bandicoot of Western Australia.

Confined to the South-West, extending as far north as the Moore River, where however it is said to have become very scarce.

Generally frequenting damp and marshy localities, where it hides among reeds and thick scrub.

It makes a nest on the ground of dry grass and sticks, rather like that of *Bettongia penicillata*, only much flatter, generally either hidden beneath a fallen tree or in the middle of a bush; the animal making for the nearest hollow log or thick patch of scrub when disturbed.

Although generally nocturnal this species frequently comes out in early evenings, and occasionally during the day. The stomachs of all specimens examined contained wing-cases and legs of beetles and other insects, but the animals also feed freely on roots and other vegetable matter.

33 specimens collected. Albany (King River) (Big Grove); Wagin (Arthur River); Brookton (Dwaladine); Pinjelly (Woyaline Wells); Margaret River (Burnside); Busselton (Yallingup).

Bandicoot or Native Pig of Colonists.

'Quaint' or 'Waint' (Beverley), 'Queenda' (Margaret River), of natives.

*PERAMELES BOUGAINVILLEI* Quoy & Gaim. (Text-fig. 267, p. 835.)

Occurring on the islands off Sharks Bay. Probably owing to the introduction of a number of cats on Bernier Island, it has become very rare there.

The Perth Museum has a very old specimen from Dorrée Island. It appears to be a smaller and less distinctly marked animal than the South-Western subspecies.

1 specimen (skull) collected—Bernier Island.

*PERAMELES BOUGAINVILLEI MYOSUROS* Wagn. (Text-fig. 267.)

Apparently not plentiful in the South-west, although described by natives as being fairly numerous in the Salt River district.





Text-fig. 267.

Map showing distribution of *Perameles bougainvillei* and *P. b. myosuroides*.

## CHEROPUS CASTANOTIS Gray. (Text-fig. 268, p. 836.)

I was not able to find out anything definite about the distribution of this species in Western Australia. It is evidently very rare. The specimen obtained by Gilbert in 1843 seems to have been the only one ever secured in this State: it is labelled "Boorda (Kirltana)," a place I could find no record of except that it may refer

to Cape Borda in the extreme North-West, near Cape Levéque at the entrance of King Sound.

A small Bandicoot, doubtfully described from around Port

Text-fig. 268.

Map showing distribution of *Chæropus castanotis*.

Hedland, said to frequent rocky situations, may be this species; while an animal that is said to be now extremely rare, if not entirely extinct in the district, described to me from around Beverley and York, may be the same. Known to the Colonists as the Camel-foot.

'Buddile' of natives (Beverley).

Dr. G. C. Stirling, of the Adelaide Museum, tells me that, although extremely scarce in South Australia, *Chieropus* has been obtained in the interior, both to the north and south of the Macdonnell Ranges, and inland from Fowler's Bay on the south coast.

*DASYURUS GEOFFROYI* FORTIS Thos. (Text-fig. 269.)

Fairly numerous in many parts of the South-West to as far

Text-fig. 269.



Map showing distribution of *Dasyurus geoffroyi fortis*.

north as Watheroo or Geraldton. Originally recorded from Sharks Bay, where it no longer exists, frequenting rocky and well timbered country; plentiful along the sea-coast in the Margaret River district, where, judging by the number of their tracks along the sea-shore, they feed largely on marine refuse.

Text-fig. 270.

Map showing distribution of *Phascogale flavipes leucogaster*.

Killed off as much as possible in the agricultural and more



thickly populated districts on account of being so destructive to poultry.

Not extending far inland. Arboreal and nocturnal, hiding by day in crevices among rocks, deserted burrows, hollow logs, &c.

Very much resembling Viverrine animals in habits.

30 specimens collected. Wagin (Arthur River); Beverley (Avon River); Brookton (Dwaladine); Pinjelly (Woyaline Wells); Busselton (Beachlands; Yallingup); Margaret River (Burnside).

Native Cat of Colonists.

'Chuditch' (Beverley), 'Gnuljargneet' (Busselton), 'Barrygit' (Moore River), of natives.

*PHASCOGALE FLAVIPES LEUCOGASTER* Gray. (Text-fig. 270.)

Confined in the South-West to the coastal and well-watered forest districts.

The specimens obtained near Albany were trapped in rough ironstone country timbered with Jarrah and Red Gum. Formerly obtained in the Victoria Plains near Northam by Gilbert, where it is now without doubt extinct; nearly all the small marsupials appear to have died out in that district.

6 specimens collected. Albany; Kojonup.

*PHASCOGALE CALURA* Gld. (Text-fig. 271, p. 840.)

Very rare, seeming hitherto to have been recorded only four times from Western Australia: once from the Williams River, where it was originally obtained by Gilbert, and three times since from around Kojonup.

The British Museum has an old specimen from Adelaide, which seems to be the only known instance of its capture in South Australia.

1 specimen collected. Kojonup (in Perth Museum).

*PHASCOGALE PENICILLATA* Shaw. (Text-fig. 272, p. 841.)

Although not plentiful this species seems to have a more general range in South-Western Australia than the smaller *Phascogales*.

Doubtfully recorded from as far inland as Kalgoorlie, where it would probably only be a straggler. Said to be generally distributed throughout the southern parts of South Australia.

Arboreal. Very active among the branches of trees. Occasionally frequenting the neighbourhood of farms, where according to natives they come after mice.

4 specimens collected. Busselton (Yallingup); Margaret River (caves) (skull).

Squirrel of Colonists.

'Coming-coming' (Beverley), 'Wambgner' (Busselton), of natives.

*PHASCOGALE APICALIS* Gray. (Text-fig. 273, p. 842.)

Confined to the forest districts of the South-West, where it is apparently a rare species.

3 specimens collected. Albany (in Perth Museum).

Text-fig. 271.



Map showing distribution of *Phascogale calura*.

*PHASCOGALE BLIGHI* Woodward. (Text-fig. 273.)

A medium sized species with a distinctly incrassated tail,



spending a great deal of their time on the ground, while *P. blighi*, occurring in comparatively treeless country, would seem to be almost if not entirely terrestrial.

Text-fig. 273.



Map showing distribution of *Phascogale apicalis* in S.W. and *P. blighi* in N.W.

*SMINTHOPIUS MURINA* Waterh. (Text-fig. 274.)

Occurring throughout the South-West; appears to be more plentiful in the coastal districts wherever grass-trees (*Xanthorrhæa*) occur.



Arboreal to a certain extent, occasionally making their nests or hiding in the hollow stumps of dead grass-trees or eucalypti.

Text-fig. 274.



\* Map showing distribution of *Sminthopsis murina*.

6 specimens collected. Albany (King River); Margaret River (Burnside).

Pouched Mouse of Colonists.

'Dunnart' (Margaret River) of natives.

On account of their habit of hiding among fallen timber or tree-stumps, the marsupial mice must invariably get exterminated wherever bush fires occur. This species, as well as *Dromicia* and the small *Phascogales*, has consequently become very scarce, especially in the agricultural and more thickly populated areas. In addition it is probably to a great extent killed off by the cats that have run wild in large numbers.

Text-fig. 275.



The numerous recent remains at the bottoms of the circular precipices around the mouths of many of the Margaret River caves, even of the large marsupials, including *Macropus giganteus*, *M. brachyurus*, *Potorous gilberti*, *Trichosurus*, *Pseudochirus*, *Isoodon*, (*Canis dingo*), as well as small rodents and marsupial mice, give an idea of the enormous destruction caused by bush fires. In the same district, while walking through a tract of country that had been burnt off, I picked up 18 burnt bodies of *Pseudochirus*, as well as odd individuals of other species.

SMINTHOPSIS CRASSICAUDATA Gld. (Text-fig. 275.)

Apparently rare in Western Australia where, however, it seems to have a wide range.

Differing from *S. murina* in frequenting dry sandy and often treeless districts.

The Perth Museum has two specimens from Day Dawn and Dongarra, while it was originally obtained by Gilbert in the Williams district.

Occurring, according to natives, on the coastal sand-plains to the east of Albany.

2 specimens collected. (In Perth Museum—from Central South Australia, where it also occurs.)

MYRMECOBIUS FASCIATUS Waterh. (Text-fig. 276, p. 846.)

Diurnal. Fairly numerous, although rather scattered, throughout the inland forest districts of the South-West, especially where the prevailing trees are the White Gum (*Eucalyptus redunca*) and the Jam (*Acacia acuminata*).

Not extending to the West Coast.

Becoming rare to the north of Beverley, a few being said, however, to still occur as far north as Watheroo.

According to natives this species at one time extended into the interior, while the Perth Museum has an old specimen obtained from near Coolgardie.

Although a forest animal it is not arboreal, never climbing trees; when alarmed generally making for the nearest hollow log. Its habit of sitting up to watch anything gives it a great resemblance to an African Meerkat.

Not naturally timid, and unless startled by a sudden movement, it is often possible to approach within a few yards. If caught alive, it does not attempt to bite.

The natives say that during the breeding-season it makes a rather shallow perpendicular hole in the ground which the female lives in when she has young, and that when they begin to grow big she does not carry them about with her.

Dr. G. C. Stirling, of the Adelaide Museum, tells me that the South Australian specimens were mostly obtained near the north-west bend of the River Murray, where it was formerly plentiful, but that it must be now either very rare or entirely extinct, as it has not been obtained there for many years.

12 specimens collected. Wagin (Arthur River); Beverley (Boyadine-Dale River); Busselton (Dwaladine); Pinjelly (Woyaline Wells).

Ant-Eater of Colonists.

'Numbat' of natives (S.W.).

Text-fig. 276.



Map showing distribution of *Myrmecobius fuscatus*.

NOTORYCTES TYPHLOPS Stirling.

This species has not yet been discovered in Western Australia



south of the tropics, although there is little doubt that it occurs throughout the far central districts.

In South Australia it has been obtained near Fowler's Bay in the extreme south, and around Charlotte Waters telegraph-station (about latitude  $26^{\circ}$ ), while it was quite recently secured in North-Western Australia about a degree south of the Kimberley district, in Spinifex country, between Johanna Springs and the spot where Col. Warburton's track cuts that of Carnegie made in 1897.

Text-fig. 277.

Map showing distribution of *Tachyglossus aculeatus ineptus*.

Other Central-Australian mammals most probably occur in the Spinifex country of the far interior of Australia. *Antechinomys spenceri* has been obtained from Central South Australia. A small jumping pouched mouse, said to exist in the rocky hills round Laverton, might be referable to this species.

TACHYGLOSSUS ACULEATUS INEPTUS Thos. (Text-fig. 277, p. 847.)

Widely distributed over Western Australia except in the extreme south-west; recorded from Kojonup, but seldom seeming to extend south of the rocky country around York and Beverley. Although nowhere plentiful it appears to be more numerous in the North-West than elsewhere.

Generally frequenting dry and rocky situations. Sluggish in its movements, curling up like a hedgehog if irritated. Apparently a great wanderer, often turning up in districts where it has seldom if ever been observed before, even by natives.

Although the claws are very powerful and well adapted for digging, they seem to be used chiefly for tearing up anthills, and the animal does not seem to be truly fossorial; but when disturbed in sandy country it is said to be able to bury itself underground like a mole, quickly disappearing from sight, while if the country happens to be hard or rocky, it will cling to the surface so tightly that it is quite difficult to dislodge it. If placed in water it is a quick and powerful swimmer.

Doubtfully described from Barrow Island.

5 specimens collected. Southern Cross (Parker's Range); Gascoyne River.

Native Porcupine of Colonists.

'Ningan' (S.W.), 'Bokaboi' (N.W.), of natives.

## 2. Notes on some Amphipoda from the North Side of the Bay of Biscay. Families PLEUSTIDÆ and EUSIRIDÆ. By E. W. SEXTON \*.

[Received September 20, 1909.]

(Plates LXXX. & LXXXI.†, and Text-figures 278 & 279.)

I am indebted to Dr. Allen for the opportunity of examining the collection of Amphipoda taken by the S.S. 'Huxley' from the north side of the Bay of Biscay in August, 1906; and for specimens most kindly sent me for comparison I have to thank Dr. Hansen, Professor Sars, Dr. Scharff and the Trustees of the Dublin Museum, Mr. Tattersall, and Dr. Vanhöffen.

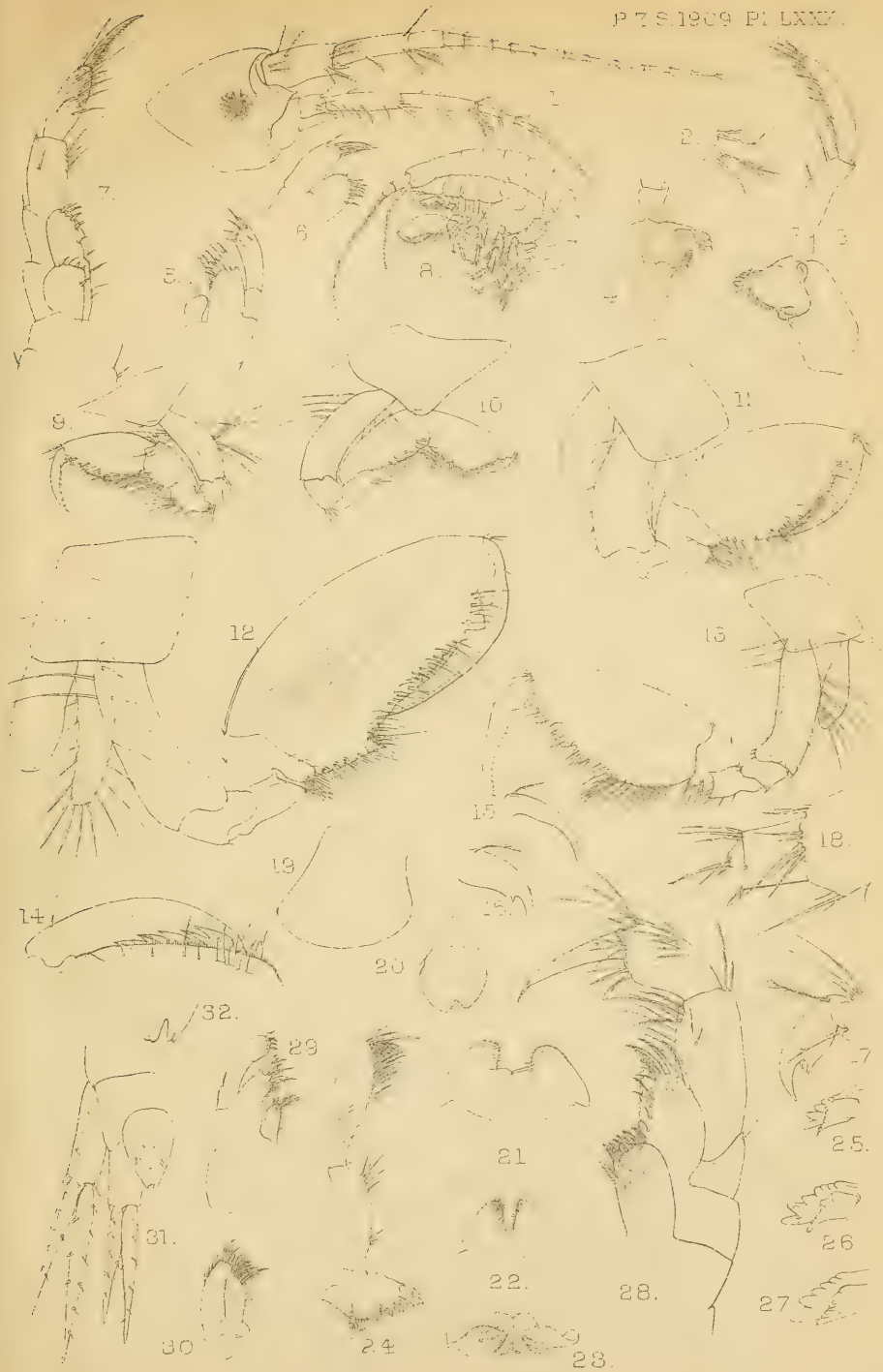
### *Variations due to Sex and Age.*

The collection, though small, proved of great interest.

In some species several stages of development were found,

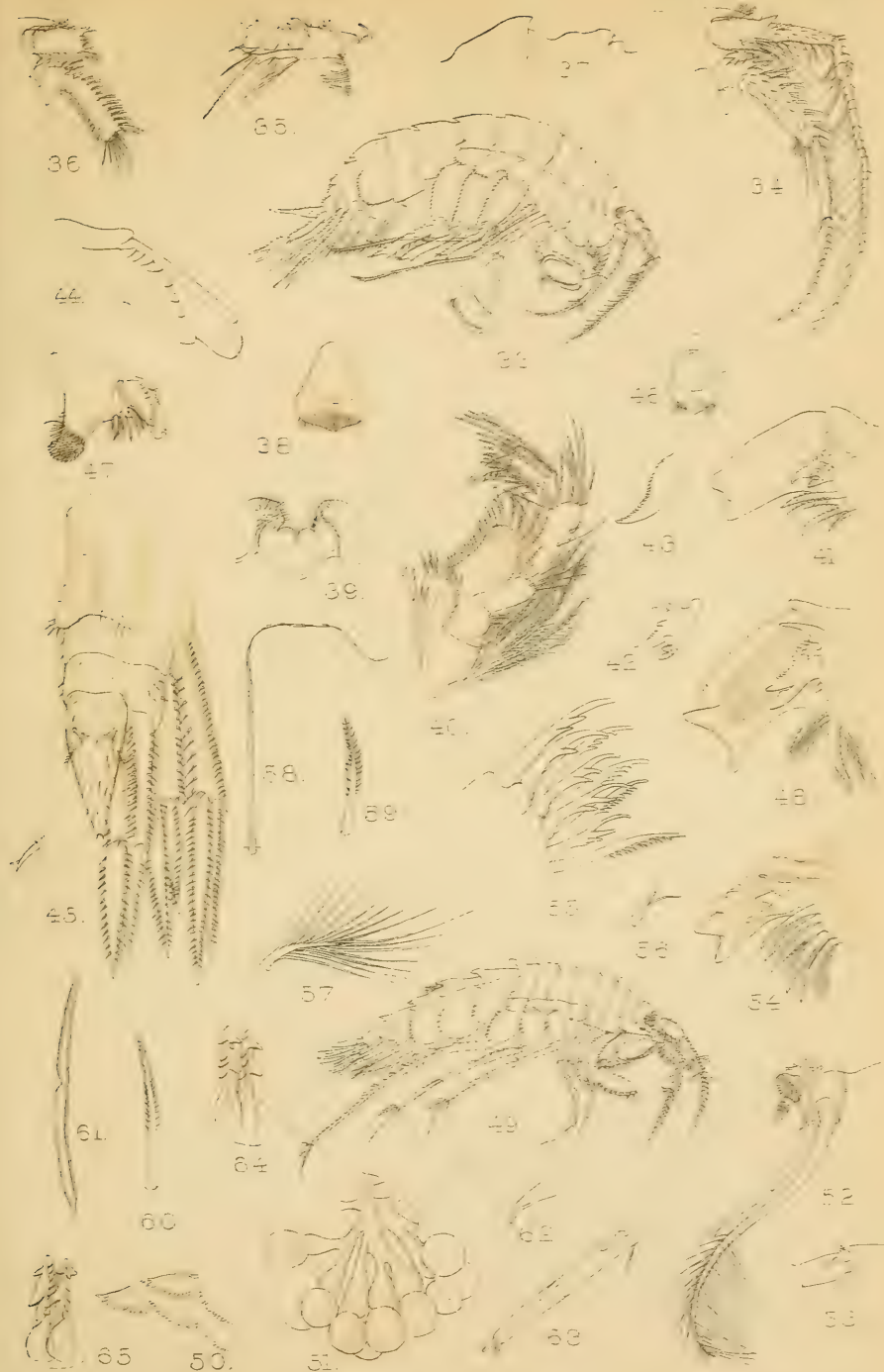
\* Communicated by Dr. W. T. CALMAN, F.Z.S.

† For explanation of the Plates see p. 878.









E.W. Sexton del.

H. J. Lenoir.

33-45. *EUSIRUS BISCAYENSIS*, Bonnier.46-48. *RHACHOTROPIS ROSTRATA*, Bonnier.49-65. *RHACHOTROPIS HELLERI*, Boeck.



which appear to prove conclusively that not only do these animals become sexually mature before attaining their full growth, but that *in both sexes* the secondary sexual characters undergo considerable modification *after* sexual maturity is reached, the character most affected being the second gnathopod. Hitherto it has been accepted as a general rule amongst Amphipods that the male only has been modified, and that it is subject to variation in a far greater degree than the female; but an examination of this material shows that the female undergoes quite as much modification as the male, though owing to the usually smaller size of its gnathopods, the changes are less noticeable. (For an example of diversity in the shape of the gnathopod hand of an ovigerous female see *Sympleustes grandimanus*, Pl. LXXX. figs. 11 & 12.) In some species the degree of difference between the stages of development is negligible; in others it is of remarkable extent, so much so that the two extremes of a series of stages might be taken for absolutely distinct species. Further knowledge on this point will lead to a considerable revision of specific nomenclature.

The variation in the gnathopod of the male has been noted by many writers, the first to discuss it being Fritz Müller (20) pp. 16-18. Müller figured two forms of the hand of the male of *Orchestia darwinii*, and stated that there were "nur zwei durch keinerlei Zwischenglieder verbundene Formen." He considered it a case of true dimorphism. Darwin quoted Müller's observations in support of his argument for Sexual Selection, (12) vol. i. p. 332, vol. ii. p. 215. Faxon also refers to them, (14) p. 43, (15) pp. 12 and 111, and suggests as explanation, that the two forms may be, as in *Cambarus*, alternating periods in the life of the individual, one form being assumed during the pairing season, and the second form during the intervals between the pairing seasons. Della-Valle (13) p. 508, attributes the differences in the two forms of the male of *Orchestia darwinii* to development; so also Stebbing (40) p. 545, where the animal is described from Müller's drawings. Geoffrey Smith (33) in a series of observations on *Orchestia deshayesii* and *O. gammarellus* has made the important discovery "that the males of these species, when breeding is not going on, assume a semi-hermaphrodite condition of a quite indubitable kind"; and that it is during this period of sexual suppression that active growth takes place. He states (p. 91) that "the antagonism that exists between the functional activity of the sexual organs and growth of the body . . . appears to result in the phenomena of high and low dimorphism *only in the male sex*." It should be noted, however, that Boulenger (5) has recently questioned these conclusions.

The development of the female would appear to proceed on totally different lines, and to follow a steady course from immaturity to full growth. In one species, *Rhachotropis helleri* Boeck (*infra*, p. 869), I was able to examine a large number of specimens, about 250, and to trace a continuous series of stages of development. The stages are easily observed in this species because

of the great modification of the chitinous cuticle of the body with age. In the young from the incubatory pouch, 2.25 mm. long, the dorsum is perfectly smooth, but, under a high power, a microscopic sensory setule can be seen, inset at each point where later either a carina or a hump is developed. The first dorsal hump of the pereon does not develop till the animal has attained a length of 5 mm., and not until two stages later, when it is a little more than half-grown, can the sexes be distinguished. At this stage, 8-9 mm. in length, with three dorsal humps developed, the young female shows the incubatory lamellæ just budding as small excrescences, and the young male carries the characteristic masses of sensory filaments on the antennæ. At the next stage in the female, 10 mm. length, with four dorsal humps developed, breeding has commenced, the eggs are extruded and carried in a large mass attached to the 5th segment, but the lamellæ are not more than half-grown, and only cover about half the egg-mass. In other animals at this same stage, presumably older, measuring 10.5 mm., the incubatory lamellæ are fully expanded and closed to form the pouch. All the remaining stages, to the full-grown female with seven well-marked dorsal humps, carry eggs, and all have the lamellæ fully expanded.

Sexual dimorphism is a common feature of the Amphipoda, the second gnathopod being the organ generally affected. One species in the 'Huxley' collection, *Sympleustes grandimanus* Chevreux, displays a very unusual and marked type of dimorphism, the side-plates and pereopods differing widely in the sexes, as well as both the gnathopods (*infra*, p. 857).

An examination of the present material shows that the mouth-organs are practically constant through the various stages, only the number of spines and setæ increasing with age; they would appear to be the safest characters on which to base specific distinctions. The antennæ and gnathopods, from which such characters are usually drawn, are the parts always the most affected by sex and development. But it is in the sensory equipment of the animal that most change is to be seen after sexual maturity is reached: the ommatidia increase in number; the flagella of the antennæ increase in length, those of the male to a far greater degree than those of the female; the calceoli, sensory filaments ("olfactory cylinders," "Riechzapfen"), &c. develop in both sexes; and the peduncles of the antennæ in the male become covered with masses or thick tufts of sensory filaments or sensory setæ.

There seems to be surprisingly little individual variation in the different stages, taken under the same conditions, though animals in the same stage of development but captured in different localities show considerable variation in size. I examined over 100 individuals of one stage of *Rhachotropis helleri* Boeck, from the S.W. of Ireland, taken in one haul, and they differed from each other neither in size, nor proportions, nor even in the



number of the setæ and spines with which they were provided; but on comparing them with Norwegian specimens at the same stage, taken in shallower water, a difference in size was at once perceived, the Norwegian specimens measuring 12 mm. in length as against the 10 mm. of the Irish ones.

The classification followed is that of Stebbing's 'Das Tierreich: Amphipoda.'

The measurements of the whole animal in all cases are taken from the tip of the rostrum to the tip of the telson.

#### Fam. PLEUSTIDÆ.

##### Genus PARAPLEUSTES Buchholz, 1874.

Syn. 1859. *Paramphithoë* (part) Bruzelius (7).

1860. „ Boeck (1).

1865. „ Goës (16).

1870. „ Boeck (2).

1874. *Parapleustes* Buchholz (8).

1876. *Pleustes* Boeck (3).

1882. *Paramphithoë* G. O. Sars (27).

1887. „ Hansen (17).

1893. „ G. O. Sars (29).

1906. *Neopleustes* Stebbing (40).

In 1874 Buchholz founded the genus *Parapleustes* on the type species *P. gracilis*. He recognised its near relation to the older genus *Paramphithoë* Bruz., and stated (p. 337) that he had hesitated as to the identity of his species *P. gracilis* with Boeck's species *Paramphithoë glabra*, but had decided that the differences in the form of the body and more particularly of the mandibles justified the institution of a new genus for it\*. His account of the genus, apart from the description of the mandibles which was founded on error, agrees in every particular with *Paramphithoë*. The type species was later identified by Hansen (17) with *Paramphithoë brevicornis* Sars. That this identification is correct, and that Buchholz's description and figures of the mandibles are erroneous, I have been enabled to prove, thanks to the courtesy of Dr. Vanhöffen and Dr. Hansen, by dissecting one of Buchholz's type specimens of *Parapleustes gracilis* and comparing it with one of Sars's type specimens of *Paramphithoë brevicornis*. Sars, however, identified *P. gracilis* with Boeck's species *glaber*, altering Buchholz's generic definition of the mandibles from "völlig ohne Spur eines Kauhöckers" to

\* "Ich muss gestehen, dass es mir etwas zweifelhaft bleibt, ob die nachstehend beschriebene kleine Art von Ostgrönland mit den angeführten Synonymen [? an: *Amphithopsis glaber* Boeck; ? *Paramphithoë exigua* Goës; *Paramphithoë glabra* Boeck] identisch ist, da die sehr kurzen Angaben von Boeck und Goës hierüber beträchtliche Zweifel bestehen lassen. Ich ziehe daher vor, sie als neue Art zu beschreiben und glaube sie mit der vorigen, wegen der ziemlich beträchtlichen Abweichungen in der Bildung der Mandibeln und Körperformen, nicht in derselben Gattung vereinigen zu können." Buchholz (8) p. 337.

"molar expansion well-developed and of cylindrical form, exhibiting the usual fluted triturating surface" (29) p. 357. The two species are, however, absolutely distinct, as will be seen on comparison of the detailed figures of *P. gracilis* given below with Sars's figures of *P. glaber* in vol. i. of the 'Crustacea of Norway', pl. 126. fig. 1, *gracilis* having the typical molar of the *Paramphithoë* degraded and almost rudimentary, while that of *glaber* is well-developed and cylindrical.

Stebbing (40) has retained the generic name of *Paramphithoë* Bruz., for *Acanthosoma hystrix* Owen and allied species, substituting the new generic name of *Neopleustes* for *Paramphithoë pulchella* Kröyer and its allies. The type species of *Parapleustes* Buch. being now proved to be a true *Paramphithoë* in the sense in which Sars uses the name, and the genus *Parapleustes* thus becoming a synonym of *Paramphithoë*, the generic name *Parapleustes* must take precedence over *Neopleustes* Stebbing, and this latter name must therefore be cancelled.

The species *glaber* Boeck falls into line with the *Amphithoë latipes* M. Sars, and for these, with *Amphithopsis pulchella* G. O. Sars, *A. olrikii* Hansen, and *A. grandimana* Chevreux, Stebbing (39) proposed in 1899 the generic name of *Sympleustes*.

PARAPLEUSTES GRACILIS Buchholz, 1874. (Plate LXXX. figs. 1-7.)

Syn. 1874. *Parapleustes gracilis* Buchholz (8), pp. 269, 299, & 398, Taf. vii. fig. 1.

1882. *Paramphithoë brevicornis* Sars (27), p. 98, Taf. iv. fig. 11.

1887. " *gracilis* Hansen (17), p. 124.

1893. " *brevicornis* Sars (29), pp. 353, 359, pl. 124. fig. 2.

1906. *Neopleustes brevicornis* Stebbing (40), p. 313, and *Parapleustes gracilis* p. 320.

The specimen described below is an adult ovigerous female, measuring 6.75 mm.; the specimen of *Paramphithoë brevicornis* Sars, with which I have been able to compare it, is also an ovigerous female but smaller, measuring only 3.75 mm. Sars gives the average length of the adult female as "scarcely attaining 4 mm.," but he appears to have had only young specimens to examine, which, while sexually mature, were not full-grown.

Hansen (17), p. 124, says that the single specimen he examined agreed with both Buchholz's and Sars's descriptions and figures, excepting in one or two trifling details: viz., the superior antennæ were rather longer than these authors stated, and the 2nd joint of the peduncle was very little shorter than the 1st, agreeing with Buchholz's figure, Sars on the other hand showing it as considerably shorter than the first joint. The same difference occurs in the two specimens I have examined, and the proportions of the joints of the first gnathopod also differ somewhat, but apart from these small details, due entirely to age

and development, the specimens are in absolute agreement on every point.

The mouth-parts are figured afresh, Buchholz's figures and descriptions not being accurate. In my opinion a great many inaccuracies arise from the custom some authors have of mounting their specimens before describing or figuring them. This appears to be a case in point. I could not at first discover how Buchholz could possibly have overlooked the molar (which, small and degraded as it is, can be plainly seen under the 1 in. obj.), until I tried placing the mandible in the position represented by him and mounting it. The exact effect of his figure was immediately obtained, through the weight of the cover-glass flattening and depressing the delicate pellucid molar ridge to such an extent as to render it indistinguishable from the body of the mandible.

*Side-plates.*—The hind margin of the first three side-plates is entire with 3 or 4 setules inset, and a single denticle at the inferior angle, not 3 sharp teeth as described by Buchholz who apparently mistook the insertions of the setules for incisions of the margin.

*Head* (fig. 1).—Lateral corners more pointed in Buchholz's specimen.

*Antennæ. Superior.*—1st and 2nd joints of the peduncle subequal; 3rd joint half the length of the 2nd. In Sars's specimen the 1st joint equals in length the 2nd and 3rd combined. The first two joints carry extremely fine ciliated hairs. *Primary flagellum.*—Buchholz gives 15–16 joints; Sars, "12 articulations only." Buchholz's co-type had 12 joints, Sars's, 13 joints. The 1st joint of the flagellum is shorter than the 2nd. All the joints carry delicate setæ, with long thread-like tips, and in addition to these setæ, the alternate joints beginning with the 2nd are each provided with a very long, hyaline sensory filament, inset on the inner surface in a line with the accessory flagellum. The *accessory flagellum* (fig. 2) is present in both co-types, but quite rudimentary and microscopic in size. It consists of a minute pellucid flat joint carrying one ciliated hair and one long thread-tipped seta. I have found this microscopic accessory flagellum in all the other members of the family I have examined, distinct in *Sympleustes latipes*, but too small to be of any value in classification in the others.

*Inferior.*—The proportions of the peduncle joints are as given by both authors, but the peduncle is longer in proportion to the flagellum in Buchholz's specimen. *Flagellum* 6-jointed.

*Oral parts.*—Upper lip unequally bilobed, incision oblique.

*Lower lip.*—Outer lobes very large and rounded; inner lobes not projecting. Both lips covered with fine downy hair; the outer lobes of the lower lip each with a cluster of 5 or 6 stronger hairs.

*Mandibles* (figs. 3 & 4).—The anterior portion of the mandibles forms a scoop-like projection, almost triangular, with the

apex of the triangle at the insertion of the palp; the strong ridge which runs down from this point to the posterior end of the spine-row carries the molar on its inner surface at the base. When the mandible is in position, this ridge hides the molar from view; in the figures both mandibles are turned to show the molar. The *molar* is oval, the crown indented in the middle, with faintly marked but distinct transverse ridges. *Cutting-plate* on the right mandible (fig. 3) strong and curved, divided into 8 teeth, the terminal tooth broad and truncate, the 2 above large and pointed, and the 5 upper ones small and rounded; no accessory plate. On the inner surface the cutting-plate is so ridged as to give the appearance of the teeth being coalesced for nearly the whole length of the plate; the apices of the teeth are considerably bevelled also, presenting a broad, ridged edge. Buchholz considered the formation to be due to the accessory plate having become coalesced with the cutting-plate in both mandibles. The left mandible (fig. 4) possesses a well-developed *accessory plate*, the margin of which is divided into 9 teeth, the lowest tooth being the largest. The cutting-plate is strongly curved, the upper half arching over almost at right angles to the lower portion; the upper portion has 5 or 6 very small rounded teeth, the lower being divided into 3 large, rounded teeth, bevelled and ridged as in the right mandible. The two plates are set very closely together; Buchholz in his figure confused them, and represented them as one plate, with 2 rows of teeth on the margin. There are 4 spines in the left *spine-row*; 6 in the right. The spines are short, stout, and have a downy appearance, being covered with microscopic spinules; behind each spine a few fine hairs are inset. The *palp* is exceedingly large; the 2nd joint lightly curved, with 2 strong spines; the terminal joint the longest, falciform, and covered on the outer surface with minute spinules. It carries on the inner margin 5 feathered spines in the right mandible, 4 in the left.

*Maxilla 1* (fig. 5).—*Outer plate* broad, with 2 rows of strong spines at the apex; 5 in one row, graduated in size, curved and bifurcate; 4 in the other row, longer, more slender, and finely serrated. The *inner plate* is small and rounded, widening at the apex, and provided with 1 plumose seta, in place of 5 setæ figured by Buchholz. *Palp* long and slender; the apex of the terminal joint carries 7 simple spines, 4 on the margin and 3 inset submarginally.

*Maxilla 2* (fig. 6).—Buchholz's description is incorrect. Both plates are broad and rounded; the *outer* is longer and only slightly narrower than the inner, and carries 1 short and 5 long stiff setæ apically; the *inner plate* has shorter curved setæ on the inner margin and a few fine hairs.

*Maxillipeds* (fig. 7).—Plates small and narrow. The *inner plate* has the inner margin straight, with 1 strong tooth inset, the outer margin convex, and the apex truncate and beset with 2 small teeth and 2 small setiform spines. The *outer plate* only



reaches to a little above the base of the 2nd joint of the palp, not to the middle, as Buchholz says; it is furnished with 9 lightly curved setiform spines, the apical ones inset considerably within the margin. The *palp* is long, the joints not greatly differing from each other in length. The 2nd is a little longer than the 1st; the 3rd and 4th are subequal, and longer than the 2nd; the 3rd is slightly attenuated distally; the 4th forms a strong, almost straight claw, with a row of spinules along its inner margin. The greater part of the claw and the upper half of the 3rd joint are covered with these spinules, and, in addition, the 3rd joint carries a number of strong setæ on the inner surface, the apical ones nearly as long as the succeeding joint.

*Gnathopods*—exactly alike in both specimens with the exception of a slight difference in the length of the joints of the first gnathopod in Buchholz's specimen, due, I consider, to age and fuller development. In this specimen the first gnathopod is slightly longer than the second; the 2nd and 6th joints are subequal to each other in length (as in Sars's specimen) but longer in proportion to the side-plate; the hand is a little longer than the hand of the second gnathopod, but agrees with it in all details.

*Peræopoda*—exactly alike in both specimens. The terminal joints are more curved in the hinder peræopods than in the anterior: all are provided with a plumose seta proximally. The 2nd joints of the hinder peræopods are beset with small spines anteriorly and are serrated posteriorly, each serration having a setule inset.

The *incubatory lamellæ* are attached to the second gnathopod and the first three peræopods. The two anterior lamellæ are exceedingly large and wide, and deeply hollowed; that of the 3rd peræopod is very small and narrow, with the hind margin straight.

The *branchial vesicles* are small, that attached to the second gnathopod being the smallest; they increase rapidly in size to the 4th peræopod.

*Pleopods*.—*First pleopod*; the outer margin of the peduncle is fringed with long plumose setæ, about 14 in number; outer ramus 9-jointed, inner ramus 8-jointed, with 2 cleft spines on the 1st joint; 1st joint very large in both rami. *Second pleopod* with only 1 or 2 setæ on the peduncle; outer ramus 8-jointed; inner 7-jointed, with two cleft spines. *Third pleopod* with 1 cleft spine.

*Uropods*.—*First uropod*; rami subequal to the peduncle in length; inner ramus scarcely longer than the outer. Outer ramus in *second* and *third uropods* two-thirds the length of the inner.

*Telson*.—Exactly as figured by Sars, in both specimens. It carries 2 simple setæ near the apex, and a pair of long mobile ciliated hairs on either side.

## Genus SYMPLEUSTES Stebbing.

Syn. 1860. *Amphithopsis* (part) Boeck (1), p. 661.

1893. *Parapleustes* Sars (29), p. 357.

1899. *Sympleustes* Stebbing (39), p. 209.

1900. *Dautzenbergia* Chevreux (10), p. 73.

1906. *Sympleustes* Stebbing (40), p. 317.

Two species of this genus were taken by the 'Huxley'—*S. latipes* M. Sars, 3 specimens; and *S. grandimanus* Chevreux, 5 specimens.

## SYMPLEUSTES LATIPES M. Sars.

For synonymy see Stebbing (40), p. 317.

Three specimens, measuring respectively 7.5 mm., 4.5 mm., and 2.5 mm.

This species has been recorded once before from the Bay of Biscay, one specimen, an adult male, having been taken by the 'Caudan' Expedition of 1895.

The 'Huxley' specimens are all young forms, the largest, 7.5 mm., agreeing very closely with Sars's description and figures of the adult (29. p. 360); the other two differing in degree only. These latter have the palm margin of the second gnathopod hand almost straight and the dorsal processes scarcely perceptible. As Hansen pointed out (17. p. 135) the development of the dorsal processes, and the emargination of the palm of the second gnathopod are characters of maturity; to these may be added another character, taken from the epimera of the 3rd pleon segment: in the adult the postero-lateral corner is produced to an obtuse angle, while in the young form it is deeply notched with a setule inset. The accessory flagellum of the superior antenna, first noted by Bonnier (4. p. 646) is well-developed in all three specimens.

*Distribution:—*

Norway: M. Sars, as *Amphithoë latipes* (30. p. 139), Hammerfest and Tromsø, 30–60 fms., on Hydroids; largest, 13 mm.

A. Boeck, as *Amphithopsis latipes* (3. p. 355): largest, 9 mm.

G. O. Sars, as *Parapleustes latipes* (29. p. 362), from Finmark to the Trondhjemsfjord: 30–100 fms., on Hydroids; largest, 12 mm.

Norman, as *Parapleustes latipes* (23. p. 481), Lang Fjord: 5–15 fms.

Greenland: Norman, as *Amphithopsis latipes* (22. p. 208), 175 fms.

Hansen, as *Amphithopsis latipes* (17. p. 135), Disko etc.; 100–160 fms., on Hydroids; and on clay bottom; largest, 16 mm.

Great Britain: Shetland Isles: Bate, as *Calliope fingalli* (adult) (35. p. 377) = *Amphithoë latipes*, p. 380.

Norman, as *Calliopius ossiani* and *C. fingalli* (21. pp. 280–281); 40–90 fms.

East coast, Banff, Berwick, Yorkshire:—Bate, as *Calliope ossiani* (young form) (36. p. 262).

Channel Is. : Norman, as *Sympleustes latipes* (24. p. 366).

S.W. of Ireland : Bourne, as *Amphithopsis latipes* (6. p. 317).

N. America : off Grand Manan : Holmes, as *Sympleustes latipes* (19. p. 490); 45 fms.; 1 specimen, 15 mm.

Bay of Biscay : Taken by the 'Caudan' : Bonnier, as *Parapleustes latipes* (4. p. 645): 45° 57' N., 6° 21' W.; in 1410 m.; bottom deposit "coraux et vase"; 1 specimen, male, 10 mm.

Taken by the 'Huxley', 26. viii. 06; 48° 7½' N., 8° 12½' W.; with the Agassiz trawl in 412 fms.; bottom—sand, mud, and hard ground; 3 specimens, immature.

*SYMPLEUSTES GRANDIMANUS* Chevreux. (Plate LXXX. figs. 8–32.)

Syn. 1887. *Amphithopsis grandimana* Chevreux, ♀, (9) pp. 570–580.

1893. *Acanthozone latipes* (part) Della Valle (13), p. 608.

1897. *Parapleustes megacheir* Walker, ♂, (42) p. 230, pl. 18. figs. 4–4 c.

1899. *Sympleustes* Stebbing (39), p. 209.

1900. *Dautzenbergia grandimana* Chevreux (10), pp. 73–75, pl. x. fig. 1.

1906. *Sympleustes megacheir* Stebbing (40), p. 217.

*Sympleustes grandimanus* „ „ p. 318.

*Dautzenbergia grandimana* „ „ p. 728.

This species furnishes a remarkable example of the modification of the "secondary sexual characters" after maturity is reached, especially in the female (see figures 11 & 12.) It is interesting also as an unusually pronounced type of sexual dimorphism. The male and female, which have been described as separate species, differ not only in both the gnathopods, but, what is more noteworthy, in the shape of the first four side-plates. These in the female are practically subequal, while in the male the 4th is nearly twice as deep as the 1st. Other unusual points of difference will be found in the peræopods; the 4th joint in the female is shorter, in the male longer, than the 5th joint; and the inner margins of the fingers are dentate in the female, entire in the male.

*Sympleustes grandimanus* is distinguished from the other known species of the genus by the comparatively small side-plates; the great inequality in size of the gnathopods; the serrate fingers of both gnathopods; and the incised telson.

In 1887 Chevreux described the female of this species under the name of *Amphithopsis grandimana*, placing it near *Amphithopsis pulchella* Sars, among the *Paramphithoidæ*. In his later work, however, he formed a new genus *Dautzenbergia*, for its reception, classing this genus provisionally in the family Calliopidæ, provisionally because of the great inequality in size between the first and the second gnathopods. This same character and the difference in the form of the telson, are the reasons given for its removal from the *Paramphithoidæ*.

Sars afterwards, in his 'Crustacea of Norway,' placed his species *A. pulchella* in the genus *Parapleustes* Buchholz (now *Sympleustes*

Stebbing). Between the characters of this genus, as given by Sars, l. c. p. 357, and those given by Chevreux for *Dautzenbergia* I can find no essential difference; on two points only do the accounts vary—viz., the lower lip and the telson, and of these, the first is due to misapprehension on Chevreux's part, and the second, the difference in the shape of the telson, is only a character of specific value, and not of sufficient importance to justify the creation of a new genus. Chevreux founded his genus on a single specimen, always an unsafe proceeding, for even if, as in this case, the specimen be sexually mature, yet as these animals pass through several stages of development *after* reaching maturity (see *Rhachotropis helleri*), the presence of the incubatory pouch is no guarantee of its being fully adult. All the parts undergo more or less modification, and therefore characters drawn from a young specimen are of no value as distinguishing specific features.

*Description*.—5 specimens were taken by the 'Huxley,' measuring 3 mm., 5 mm., 5 mm., 5.5 mm., and 7.5 mm., respectively, all females. Three marked stages of growth are shown: 1 immature; 3 young females about the same stage of development as Chevreux's specimen (as will be seen by a comparison of his figures with mine); and 1 larger specimen older than the others, as shown by the further modification of the second gnathopod. The description of the male is taken from the type specimens of *Parapleustes megacheir* Walker, which, through the kindness of Dr. Scharff, I have been able to examine; the larger specimen measured 11 mm., the smaller 7 mm.

The *body* is compressed, smooth, almost pellucid, cuticle exceedingly thin; segments well-defined. Peraeon and 1st three pleon segments evenly rounded; 4th pleon segment with a marked dorsal depression. Chevreux in his first account says "les trois premières segments de l'abdomen présentent une légère carène"; this statement is omitted in his later work, and the pleon is figured as perfectly smooth and rounded. Owing to the transparency of the cuticle permitting the underlying terga of the 2nd and 3rd pleon segments to show through the overlapping posterior edges of the segments preceding them, a curious deceptive effect of dorsal teeth is produced with transmitted light (see fig. 8). Walker in describing the male (*P. megacheir*) says "second segment of pleon (metasome) having a small dorsal tooth," but in both sexes all the posterior margins are evenly curved and entire.

In the young specimens the first three pleon segments have each a small tooth at the postero-lateral corner; in the large specimens only the 2nd and 3rd are thus provided, and in a less degree than in the young; inferior margin of the 3rd segment in all, strongly curved.

*Side-plates*.—In the female the first four are subequal in depth; 1st produced anteriorly in an acute lobe, covering the post-antennal corner; the 4th the broadest, lightly excavate behind; 5th and 6th bilobed, much wider than deep. In the male, the 1st



and 2nd are small; the 3rd is considerably longer, but not much wider than the 2nd; and the 4th is the largest, inferior margin strongly curved, hind margin only a little concave (fig. 19).

*Head* nearly as long as the first two peraeonal segments; rostrum very small, recurved, more so in the female than in the male; lateral corners truncate, not much produced; post-antennal corners small and rounded.

*Eyes* large, oval; quite colourless in spirit specimens, and difficult to trace though they show clearly enough in photographs of the animal. Walker's statement, "eyes wanting," is not correct.

*Antennae*.—*Superior antennae* over two-thirds the length of the body, but the proportion varies with the age of the animal. *Peduncle*: 1st joint stout, as long as the 2nd and 3rd together; 3rd joint shorter and much more slender than the 2nd; in the young female 5.5 mm. long, and in Chevreux's first description the 3rd joint is only half the length of the 2nd. The peduncle carries some fine hyaline hairs, as well as 3 or 4 ciliated ones, but the construction of these and of the filaments and setae of the flagellum is exceedingly difficult to observe, even when magnified 500 times, because of their fragility and transparency; this probably accounts for Chevreux's description "presque absolument glabres." *Primary flagellum*.—All the flagella of the larger specimens were unfortunately broken, 34 joints remaining on one; 1st joint almost double the length of the 3rd joint of the peduncle, carrying 3 or 4 clusters of sensory filaments; the 10 succeeding joints short, each with a cluster of filaments; the remaining joints longer and thinner, provided each with small setae, and a long sensory filament. The rudimentary *accessory flagellum* is characteristic of the family; it consists of one minute, pellucid joint, flat and leaf-like, tipped with 2 or 3 hyaline cleft setae (fig. 18).

*Inferior antennae* much shorter than the superior. *Peduncle*: antennal cone large; 5th joint about one-sixth shorter than the 4th. This proportion appears constant, being the same in all the specimens examined; Chevreux in his second account has "beaucoup plus court" instead of the more correct "un peu plus court" of the original description. *Flagellum* in the young female with 14 joints; both flagella broken in the large female and in the males, 15 joints remaining in young male.

*Oral parts*.—*Upper lip* (fig. 20): Alike in both sexes. Apex unevenly bilobed, with the rather oblique incision characteristic of the genus; inner margin of the right lobe minutely crenate.

*Lower lip* (figs. 21, 22, and 23).—Inner lobes much broader than the outer lobes; a figure (fig. 23) is given to show the proportions as seen from above. In the older specimens the lip is flatter and the inner lobes larger in proportion to the outer ones than in the young animal. Sars gives as a generic character "posterior lip with the inner lobes scarcely projecting," while Chevreux has "lèvre postérieure simple, sans lobes internes." In the young animal the lower lip has a tendency to curl in on

itself, the outer lobes thus completely hiding the small inner ones; it requires to be straightened out before its true construction can be seen, and this, because of its extreme tenuity, is a difficult matter. This appears to be the explanation of Chevreux's statement; the specimen he examined was a young animal with the lower lip contracted.

*Mandibles* strong (figs. 24, 25, 26, & 27). *Cutting-plate* of the *right mandible* in the large female with the margin divided into 7 teeth, the two below very large; *accessory plate* (fig. 26) large, almost as large as that of the left mandible, but of more delicate structure, produced below to a curved tooth, upper portion of the margin crenulated, with 2 small teeth. In the young female the cutting-plate has 6 teeth (the two uppermost ones being very small) and the margin of the accessory plate is much more dentate than in the older animal, probably less worn (fig. 25). The accessory plate being pellucid and lying flat against the cutting-plate, is no doubt the reason it escaped Chevreux's notice. In the male the cutting-plate is divided into 6 teeth; the accessory plate is of the same construction as that of the female but with the inferior margin straight, not curved (fig. 27).

*Left mandible* (fig. 24).—In both male and female the *cutting-plate* is divided into 6 teeth, the second lowest being the largest; the *accessory-plate* margin into 5 teeth. The figure given by Chevreux is scarcely accurate. The right *spine-row*, male and female, contains 7 spines, the left 8, each with a plumose brush-like seta behind; the spines have a downy appearance, being covered with microscopic spinules. *Molar* prominent, cylindrical; the crown is ridged transversely with small rows of teeth; it is surrounded with fine hairs, and carries a long ciliated hair posteriorly. In the female the crown of the left molar is ridged all over, but the anterior portion of the crown of the right molar is smooth. *Palp* very large; 3rd joint unusually long, much longer than the 1st and 2nd taken together; the distal half of its anterior margin is bordered with strong bristles (19 in the female, 17 in the male), the 5 apical ones set at a different angle from the others, and feathered on both sides, while the remaining ones are feathered on one side with cleft tips; the middle bristle in the apical group is twice the length of the others. In addition to these a diagonal row crosses the joint proximally on the outer side; and the tip of the joint is covered with minute spines. The 2nd joint is produced a little anteriorly, like, but in a less degree, to that of *S. latipes*; it carries a group of bristles distally.

*First maxilla* (fig. 29).—*Inner plate* small, with 2 long, and 2 minute plumose hairs; *outer plate* in the female with 7 spines, 4 large, strong, furcate, and the other 3 longer, each with about 6 small teeth. The male has the same number of spines, but fewer teeth on the spines. *Palp* biarticulate, longer than the outer plate; apex with a row of 5 feathered spines on the margin and 3 feathered setæ submarginally.

*Second maxilla* (fig. 30).—Both plates covered with fine hairs; *inner plate* slightly the smaller, with a row of 4 plumose hairs on the inner surface, the proximal one the longest. The apices of both plates are provided with long stiff setæ, serrated for half their length.

*Maxillipeds* (fig. 28).—Female. *Inner plate*, apical margin straight with 2 small, broad teeth, and 5 setiform feathered spines; the inner margin carries 2 stout feathered spines. *Outer plate* reaching to the middle of the 2nd joint of the palp; a short, curved, flat spine with serrate edges is inset at the apex, with 3 setiform feathered spines on the right maxilliped and 4 on the left; the inner margin is produced beyond the row of spines into a delicate crenulated border (similar to that of the second gnathopod palmar border of the male). Male exactly as in female, except for an increased number of spines and setæ; 3 along the inner margin of the inner plate; and 5 setiform spines on the apical margin of both outer plates in addition to the curved spines. The immature specimen 3 mm. long has 3 on each outer plate and the curved spine at the inner angle is more slender; the construction and proportions are the same as in the adult. *Palp*, 2nd joint very large, much larger than the 3rd; 3rd produced a little anteriorly over the finger: 4th joint or finger longer than the 3rd, with a distinct nail, anterior margin edged with rows of minute spinules.

*Gnathopods* very unequal in size in the full-grown animal, though in the young there is not much difference between them. In the 'Huxley' specimens, the small 3 mm. one has the hand of the second gnathopod only one-fourth longer than the hand of the first; in the intermediate specimens 5–5.5 mm. the difference increases, the second being twice the length of the first; and the inequality is still greater in the largest specimen 7.5 mm. Of the two males examined the smaller one, 7 mm., has the second gnathopod hand twice the length of the first; the difference is greater in the larger specimen of 11 mm.

*First gnathopod* (figs. 9 & 10).—Female. 2nd joint large, curved, carrying proximally, on either side, several extremely long and delicate setæ; 4th joint cup-shaped; 5th large, produced to a transparent lobe at the posterior distal angle on the outer side, the anterior margin shorter than that of the 6th joint in all the specimens, more markedly so in the young. The shape of the 6th joint or hand varies with age; in the small 3 mm. specimen, the posterior margin is convex, palm defined by a sensory spine; but in the larger specimens the palmar angle is well produced, the hind margin is straight and about the same length as the palm. Chevreux, however, describes it thus, "son bord palmaire se confond avec le bord postérieur, et forme avec lui une courbe régulière." In examining the 'Huxley' specimens I found that the hand in the natural position is held turned inwards at an angle to the rest of the limb, bringing the palmar angle underneath, thus masking the real shape of the joint, and giving it the convex appearance described by Chevreux. In the figure (fig. 10)

I have bent the hand back to the level of the other joints, in order to show its true contour. The palm has a submarginal row of small setæ on the outer surface, and 2 or 3 clusters of longer setæ, and carries besides in all the specimens (male and female) a regular fringe of minute spinules on the margin, extending round the palmar angle. The sensory spines at the angle are notable for the great length of their apical filaments; the young female has 2 spines on the outside and 3 on the inside of the angle, the larger specimen more. Similar spines occur on the palm of the second gnathopod hand and on the pereopods. The posterior margins of the 5th and 6th joints are deeply inset with clusters of sensory setæ, and the under surfaces of both joints carry two longitudinal rows of groups of these setæ. The finger (fig. 14) is broad, curved, and serrated in all the stages, a setule being inset in each serration; the number of the serrations increases with age. The tip of the finger fits into a small groove on the inner surface of the palm between the two groups of spines at the angle.

Male (fig. 9).—The proportions of the 5th and 6th joints differ in the male. The anterior margin of the 5th joint is half as long again as the 6th, instead of only slightly longer as in the female; and the posterior margin of this joint is convex and not produced to a lobe at the distal angle. The shape of the hand is different in the two sexes, the hind margin being shorter than the palmar margin in the male, longer in the female. The finger also is longer in proportion, with more serrations.

*Second gnathopod* (figs. 11, 12, & 13) powerfully developed. 2nd joint broad and curved, with some of the long delicate setæ proximally on either side; both this and the succeeding joint are prolonged at the anterior angles in large rounded pellucid lobes. The 4th joint is produced posteriorly to a subacute lobe tipped with sensory setæ; the 5th is also produced posteriorly, to the same width as the 6th joint, its contour in the female forming one continuous line with the 6th; posterior margins of both inset with groups of sensory setæ, more in number in the larger specimens. The hand undergoes a remarkable amount of modification with the growth of the animal, especially in the female. Both the hand and the finger differ in the two sexes.

Female (figs. 11 & 12).—In the immature specimen 3 mm., the whole of the posterior margin is evenly curved, the palm, defined by 2 sensory spines, being the same length as the hind margin. In the young female 5.5 mm., sexually mature but not full-grown, the posterior margin is still convex, but the palm is half as long again as the hind margin, and the palmar angle is developed; while in the large female 7.5 mm., the palm is concave instead of convex, with the palmar angle acutely produced, and is more than twice the length of the hind margin. The palmar margin in the young female projects in a small subacute lobe at about one-third of its length from the finger articulation; the whole of the margin is crenate; and the tip of the finger fits into a small



hollow at the angle between the two large sensory spines. In the large female the palm is greatly elongated, the projecting lobe being one-fifth of the distance from the finger-articulation, with a deep indentation immediately following it; equidistant between this lobe and the palmar angle is a slighter indentation with a small projection following; the whole of the margin crenate. The palmar angle projects considerably beyond the palm-level, the tip of the finger impinging against the under surface of the palm some distance from the angle instead of meeting it, as in the young animal. The palm is bordered on either side with the sensory spines characteristic of this species, and with long cleft-tipped setæ, the under surface thickly setose. The finger is strong, curved and serrate; the serrations are very distinct in the immature specimen, 4 in number with a setule inset in each, as in the first gnathopod; much less distinct in the young female, 6 in number; and only visible in the large specimen under a high power, when they show as oblique incisions.

Male (fig. 13).—The hand in the young male is about twice as long as broad, with the palm half as long again as the hind margin. As in the female, transverse rows of sensory setæ are deeply inset along the hind margin, 5 in the female, 8 in the male. The palmar angle is as in the young female, the tip of the finger meeting it and fitting between the groups of sensory spines. Walker describes the palm margin (p. 231) as "divided into three lobes with crenate edges by two deep sinuses." The edges of these lobes are of very delicate structure, pellucid, with the sensory spines and setæ inset considerably within the margin. The finger is large, stout, with a deep indentation proximally on the inner edge; it has 14 of the oblique incisions in the young male. The larger male agrees with the one described, with the accentuation of the lobes and sinuses natural to the greater development.

*Peræopods*.—The 1st and 2nd peræopods are practically subequal in length; basal joints with some of the long setæ on either side, as in the gnathopods. Hinder peræopods not differing much in length, basal joints expanded, rounded oval, carrying small spines on the anterior margins, and minute setules on the posterior; 4th joints produced downwards at the posterior angle to long triangular lobes; 5th joints also produced but in a less degree. The female differs from the male in having the 4th joints shorter than the 5th, instead of longer; this difference is very slight in the first two peræopods, but marked in the hinder ones. Another difference lies in the terminal joints; those of the female being provided with two small teeth on the inner margin, while those of the male have the margin entire (figs. 15, 16, and 17). All the terminal joints carry a plumose hair on the outer curve. The finger of the 3rd peræopod in the female differs a little in form from the others; it is more hollowed underneath, and has the second auxiliary tooth much produced. The sensory spines are as in the gnathopods.

*Branchial vesicles* and *incubatory lamellæ* comparatively small. The large female had four eggs remaining in the incubatory pouch; the eggs very large in proportion to the animal's size, exceeding in length the head of the first gnathopod.

*Pleopods* very long. All the peduncles are provided with fine hairs; coupling-spines very small, apices recurved, with 2 small teeth on one side and 3 on the other. In the 1st and 2nd pairs the rami are longer than the peduncle, 12-jointed; 4 cleft spines on the inner ramus of the 1st pair, 3 on the 2nd. In the 3rd pair the rami are subequal in length to the peduncle, 10-jointed, 3 cleft spines on the inner ramus.

*Uropods* (fig. 31).—Apices reach to nearly the same level. The rami of the 1st pair are about subequal to the peduncle in length; the rami of the 3rd pair twice as long as the peduncle; inner rami of the 2nd and 3rd pairs longer than the outer; all the margins edged with small spines.

*Telson* (figs. 31 & 32) in the female cleft for one-quarter its length; apices each with a setule inset. In the male the cleft is slightly oblique, with the apices dehiscent. Just above the cleft on either side, a pair of mobile plumose hairs is inset, with a few scattered ones proximally. Chevreux first described the telson as rounded, but in the later account he describes and figures it as cleft.

#### Fam. EUSIRIDÆ.

For synonymy see Stebbing (40), p. 338.

Three of the four species of *Eusiridæ* collected by the 'Huxley' were taken in one haul at Station XII. in 246 fathoms. Two of these, *Eusirus biscayensis* Bonnier, and *Rhachotropis rostrata* Bonnier, are recorded for the first time since their discovery by the 'Caudan' Expedition in 1895. One specimen of the hitherto unknown male of *Eusirus biscayensis* was taken. Owing to the method of capture, the Agassiz trawl, all the specimens are more or less mutilated, the slender fragile pereopods especially suffering. The specimens of *Eusirus longipes* Boeck, the fourth species, taken at a much less depth, 109 fms., and by a different method, are in a good state of preservation; these were caught in a tow-net attached to the dredge working on the bottom.

#### Genus EUSIRUS Kröyer, 1845.

For synonymy see Stebbing (40), p. 338.

EUSIRUS LONGIPES Boeck, 1861.

Syn. Stebbing (40), p. 341.

Three specimens, males, the largest measuring 8 mm., were taken at Station IV. near La Chapelle Bank, 23. viii. 06, lat. 47° 48' N., long. 7° 25' W., in 109 fathoms; bottom deposit, coarse sand and broken shell.

This species has been recorded twice before from the Bay of

Biscay, trawled by the 'Hirondelle' at two closely adjoining stations about 110 miles to the S.E. of the 'Huxley' Station. (Chevreux (10), pp. 65, 171, 172.)

*Distribution.* Coast of Norway, 30–300 fms. Boeck (3), p. 504; Sars (29), p. 420.

Shetland Isles, 40–50 fms.; bottom deposit, sand. Norman as *E. helvetica*, (21) p. 281.

Scotland, W. coast, 10–12 fms.; bottom—mud, gravel, broken shell. Robertson (25), p. 42; Scott (31), p. 173.

Channel Islands, off Guernsey, 25 fms. Walker & Hornell (41), p. 53.

Bay of Biscay, 166 & 180 m.; bottom deposit, muddy sand. Chevreux (10), pp. 65, 171, 172.

Bay of Naples. Della Valle as *E. cuspidatus* (13), p. 669.

Adriatic. Heller as *E. bidens*, (18) p. 32.

*EUSIRUS BISCAYENSIS* Bonnier, 1896. (Plate LXXXI. figs. 33–45.)

1896. *Eusirus biscayensis* Bonnier (4), pp. 651–653, pl. xxxix. fig. 1.

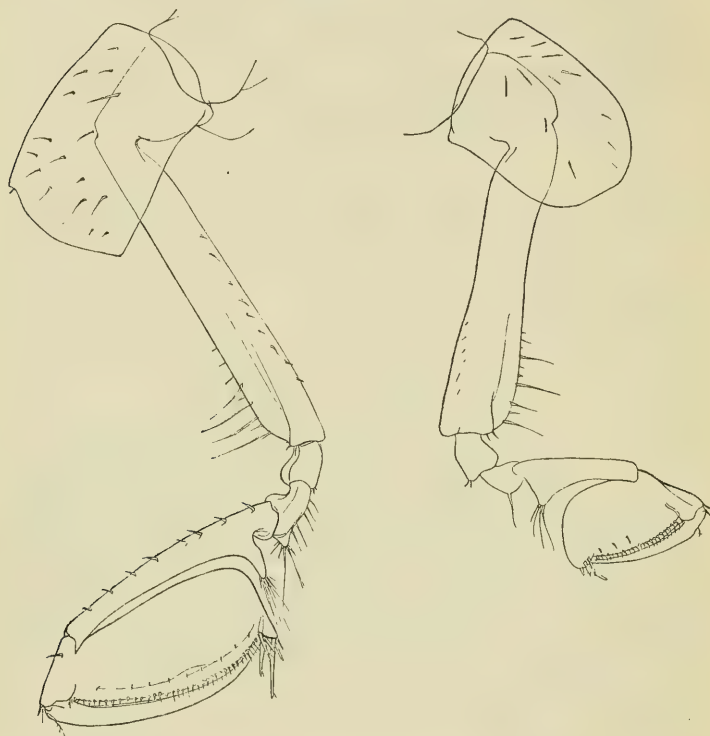
7 specimens, one male measuring barely 13 mm., and six females 12–13.5 mm. in length.

The original description was made by Bonnier from one specimen, a mutilated female, to which were lacking the superior antennæ (except the 1st joint), the terminal joints of the 5th pereopods, and the 3rd uropods. The description of a species from a single specimen is always a difficult matter, and with the arrival of fresh material, a modifying of the original account becomes necessary. Seven specimens were taken by the 'Huxley': one male, the first hitherto recorded, and six ovigerous females, all mutilated, as was to be expected from the method of capture, the Agassiz trawl. Two of the specimens, however, retained the antennæ and uropods in good condition, but in all, the hinder pereopoda were missing. A curious point is that two of the females have the 2nd gnathopod on the right side abnormal, much smaller than the corresponding gnathopod on the other side. In one the side-plate and 2nd joint are normal, the 5th, 6th and 7th joints very small; but in the other, though the branchial vesicles and incubatory lamellæ are the normal size, both the 2nd and 3rd side-plates are small and malformed, the 2nd gnathopod is much smaller (text-fig. 278, p. 866) and the 1st pereopod is only half the size of the one on the left side. It would almost appear to be due to some injury received while immature, before the development of the incubatory lamellæ. The male is easily distinguished from the female by its more slender form; by the antennæ with their dense fascicles of sensory bristles; the much shorter pereon; and by the 4th pleon segment (fig. 37), the anterior dorsal depression of which is more marked and the dorsal carina more developed.

The whole animal (fig. 33) is covered with microscopic spines and fine hairs, these last especially numerous on the pleon.

*Superior antenna.* Female (fig. 34).—First joint of the *peduncle* broad, with several dentiform apical projections; it carries a fan of fine setæ distally, and several sensory ciliated hairs; 4 long sensory hairs above and 7 or 8 small ones, and a transverse row of the small ones on its inner surface. The 2nd joint is longer than the 1st, also apically dentate, with curved spines; the 3rd

Text-fig. 278.

*Eusirus biscayensis* Bonnier.

Second gnathopods of the female, showing the abnormal right gnathopod.

joint small, widening distally, spines curved. *Primary flagellum.* In the two specimens examined the tips were broken, 32 joints remaining. The 1st joint is the largest; from the 9th–27th the joints vary in length, short ones carrying the long sensory filaments alternating with longer ones provided with small setæ only. The filaments are set in groups of 3 to 5 on the outer side of the antenna, the middle filament of each group being double the length of the others, equalling in length the six succeeding joints.



These groups occur on each joint from the 1st to the 9th, then on alternate joints to the 27th. The *accessory flagellum* (fig. 35): 1-jointed, narrowly laminar, with a large cleft spine and two divergent setæ at the apex.

Male (fig. 36).—Only the 1st joint of the *peduncle* remaining. This has the dentiform projections and sensory ciliated hairs as in the female, but is furnished posteriorly with 8 transverse rows or tufts of fine sensory bristles, extending partway round the inner side.

*Inferior antenna.* Female (fig. 34).—The 2nd and 3rd joints of the *peduncle* apically dentate; the 4th long and broad, with sinuous upper margin, thickly setose on its anterior surface, and produced at the posterior angle to a setiferous lobe; the 5th, subequal to it in length, is much narrower, with numerous small setæ anteriorly and several long fine ones distally. The *flagellum* consists of about 20 joints, each furnished anteriorly with a cluster of small setæ, those on alternate joints being longer than the others. I found no trace of the calceoli mentioned by Bonnier.

Male (fig. 36).—Only four joints of the *peduncle* remaining. The upper margin of the 3rd joint has four tufts of the sensory bristles in the right antenna, five in the left; the 4th joint carries twelve of these in the right and thirteen in the left antenna, the apical group being the largest, and containing also several long sensory ciliated hairs. This joint is produced at the posterior angle, as in the female, to a lobe bordered with long fine setæ; on the posterior margin are several clusters of the ciliated hairs, with a longitudinal row of 7 or 8 of the small ones proximally, each set in a little depression similar to those on the 1st joint of the superior antenna.

*Upper and lower lips.* Female (figs. 38, 39).—The figures given by Bonnier are not of the same magnification. *Inner lobes* of the lower lip covered with fine hairs.

*Mandibles.* Female (figs. 41, 42, 43, 44).—*Cutting-plates* greatly curved, with a strong obtuse tooth above, bidentate below in the right mandible, rounded and recurved in the left. These plates appear subject to great variation. Bonnier gives (*loc. cit.* p. 651) "apex allongé, robuste, sans denticulations; le processus accessoire est élargi et présente cinq à six dentelures sur l'un des appendices, tandis que sur l'autre il est rudimentaire, et tridenté; il est accompagné d'une rangée de cinq petits poils courts." In the three specimens examined I found the *accessory plate* of the left mandible with 8 teeth in two specimens (fig. 44), 9 in the other, 5 or 6 spines in the spine row, the *accessory plate* following the deep curve of the *cutting-plate*. In the right mandible the *accessory plate* is of a more complicated structure, divided below, the inner portion tuberculate with 3 or 4 strong teeth; the other portion variable as regards the number of teeth but with one above and one below strongly produced (figs. 41, 42). In one specimen the *accessory plate* was broken, leaving only the

inner tridentate portion intact; from Bonnier's description and figure I should imagine the same accident had occurred to his specimen. The spine-row in all three contained 4 spines. The bristles of the 2nd joint of the *palp* are plumose; those of the 3rd serrate, the two apical ones much longer than the others.

*Maxilla 1.* Female.—*Inner plate* with 2 large plumose setæ and several fine hairs; *outer plate* with 11 strongly denticulate spines, arranged in two rows on the apex, 6 in one row, longer than the others, with 4 or 5 teeth on each spine; the spines of the other row have only 1 or 2 teeth apiece (cf. *Rhachotropis rostrata*, fig. 55). Bonnier's specimen had "huit dents barbelées toutes semblables." On the inner margin of the *palp* the setæ are arranged in two parallel rows, bases contiguous, apices widely divergent.

*Maxilla 2.* Female.—Both plates nearly covered with fine hairs.

*Maxillipeds.* Female (fig. 40).—Resembling *E. propinquus*, as figured by Sars; easily distinguished from all the other species of *Eusirus* by the fan-shaped groups of exceedingly long, flexible, plumose setæ on the outer surface of the 1st and 2nd basal joints. Each seta has a broad pellucid shaft, with several longitudinal rows of delicate hairs running the whole length. There are two groups on each joint; those on the 1st joint containing 16 setæ in each fan and extending to beyond the middle of the 2nd joint of the *palp*; those on the 2nd joint each with 14 setæ, much smaller, set more closely together, only reaching to the 1st joint of the *palp*.

*Gnathopods 1 & 2.* Female.—The figure given by Bonnier is that of the first gnathopod, but through an error it is marked as the second. The second gnathopod (see text-fig. 278, p. 866) is longer than the first, the 2nd joint, for example, being as long as the 2nd and 3rd taken together of the first. The 4th joint is more produced posteriorly, forming a distinct lobe; both this and the more acute lobe of the 5th joint are provided with numerous finely serrate cleft bristles. The hand is longer though no wider than that of the first, the palm with a densely crowded row of small setæ on either side of the margin, about 60 on the inner side and 40 on the outer, with a few widely spaced setæ above. The posterior angle of the palm is bordered with 6 or 7 large sensory spines, and at the articulation of the finger is a large plumose specialised bristle (cf. also *E. longipes*, *Rhachotropis rostrata*, *R. helleri*, &c.). In the abnormal specimen there are only 25 small setæ on the inner margin and 27 on the outer.

*First and second peræopods.* Female.—Bonnier says of his specimen (p. 652): "le mæropodite n'est pas plus long que le carpopodite"; the 'Huxley' specimens differ from this, having the 4th joint longer than the 5th, as in all the other known species of *Eusirus*.

*Third pleon segment.* Female.—Hind margin nearly straight, with 23 down-turned serrations turning the corner; posterior angle rounded; lower margin produced to a strong denticle behind; 11 spinules inset submarginally.

*Third uropods* (fig. 45).—The peduncle as long as the telson; rami broad, subequal in length to the peduncle, the outer ramus a little the shorter; margins bordered with sensory spinules. The peduncle has three rows of these spinules.

*Distribution.* Taken by the 'Caudan' Expedition, 1895, 44° 17' N., 4° 38' W., in 940 metres; bottom deposit, mud.

By the 'Huxley,' August 26, 1906, at Station XII., 48° 7½' N., 8° 13' W., about 240 miles to the N.W. of the 'Caudan' station, in 246 fathoms; bottom deposit, fine sand.

Genus RHACHOTROPIS S. I. Smith, 1883.

For synonymy see Stebbing (40), pp. 347, 729.

RHACHOTROPIS ROSTRATA Bonnier, 1896. (Plate LXXXI. figs. 46-48.)

*Rachotropis rostrata* Bonnier (4), p. 653.

4 specimens, all males, measuring respectively: 10, 10, 9.5, and 9 mm.

I have only one or two points to add to the excellent description and figures given by Bonnier. On p. 655, he states: "la mandibule a un apex sans denticulations, avec un processus accessoire denticulé, bien développé sur l'un des appendices et rudimentaire sur l'autre." In these specimens, however, as will be seen by the figures (47, 48) the *cutting-plate* is elongate, incurved, with a strong tooth above, regularly crenulate in the right mandible, the lower end of which is bidentate, and having several irregular crenulations on the left mandible with the lower end rounded and deeply incurved. Both *accessory plates* are well developed; the margin of the left divided into 8 teeth; the right, as in *E. biscayensis*, of a more complicated construction, forming distally 2 strong broad teeth, with 13 serrations above, and having the upper part of the plate divided and its inner portion produced to a long falciform tooth (cf. *R. helleri*, fig. 54). The left spine-row has 3 spines, the right 2, each with a plumose brush-like bristle behind.

*Distribution.* Taken by the 'Caudan,' 1895, 44° 17' N., 4° 38' W., in 950 metres; bottom deposit, mud. 3 specimens male.

By the 'Huxley,' August 26, 1906, at Station XII., 48° 7½' N., 8° 13' W., in 246 fathoms; bottom deposit, fine sand.

RHACHOTROPIS HELLERI Boeck. (Plate LXXXI. figs. 49-65.)

For synonymy see Stebbing (40), p. 351.

20 specimens: 1 male measuring 8.75 mm.; 19 females from 10-12.5 mm. in length, one specimen with a young one 2.25 mm. long still remaining in the incubatory pouch.

These specimens showed several points of difference from the *R. helleri* figured by Sars (29), pl. 150, viz., all the segments of the pereon dorsally raised, the 7th pereonal segment with lateral carinae, and the first three pleon-segments with the

postero-lateral margins firmly serrate. On consulting Prof. Sars and Mr. Tattersall on the matter, they most kindly sent me specimens which prove these differences to be due to age. Mr. Tattersall's specimens, about 250 in number, all taken at one station by the 'Helga,' show a very interesting regular series of the stages of development, from the young in the incubatory pouch with the dorsum smooth to the full-grown female with all seven peræon-segments dorsally raised.

In this species the completion of sexual maturity in the female coincides with the development of the fourth dorsal peræon-hump at 10 mm. length. A previous stage, 8 mm., shows the incubatory lamellæ just starting as very small glabrous plates, but none of the specimens of this size had the lamellæ further expanded, nor carried eggs. Specimens 10 mm. long, with the 1st, 2nd, 3rd, and 7th peræon-humps produced, had the lamellæ half-grown, with two or three minute hairs near the apices, and carried large rounded masses of eggs protruding considerably beyond the lamellæ and flattened underneath against the body-wall. The eggs, about 60 in number, each measuring .25 mm., are supported on long bulbous stalks, branching from a short central stem by which the mass is attached to the 5th segment (see fig. 51). Specimens of 10.5 mm. length show the lamellæ fully developed, bordered with long hairs and closed to form the pouch. The eggs enclosed are separate from each other, fewer in number, and large, some measuring as much as 1 mm.

Most of the Irish specimens are at this latter stage of development, answering exactly to the description and figures given by Sars (pl. 150); the Norwegian specimens at this same stage are larger, averaging 12 mm. About 40 of the Irish specimens were larger than the rest, all ovigerous, all with the 1st, 2nd, 3rd, 6th, and 7th humps, and the lateral carinæ of the 7th segment, and in most cases with the 4th and 5th humps perceptible as slight swellings of the posterior margins.

Of the 'Huxley' specimens, 18 of the 19 females were full-grown, with all seven dorsal humps produced. The remaining female, of 10 mm. length, had only six humps, that of the 5th segment not being developed. This specimen is younger than the others, as is proved by the fact that the antennæ had only 10 joints in each flagellum, instead of the 12 joints of the larger animals.

The males are distinguishable from the females at a glance by the shorter, more compressed peræon, and the long filiform flagella of the antennæ. Unfortunately, none of them are full-grown, though sexually mature, as shown by the development of the antennæ. Of the Irish specimens, 14 measure 10 mm. In all these the 7th hump is large and the 1st very small, the other segments smooth; no trace of the lateral carinæ on the 7th; the antennal joints as Sars has figured them, the 4th joint of the peduncle of the inferior antenna being three-quarters the length of the 5th.



The single male specimen taken by the 'Huxley' measures 8.75 mm. and has apparently just undergone ecdysis, the integument being exceedingly thin and transparent and easily crumpled. The whole animal is much more slender and compressed than the Irish specimens, probably owing to its condition; it differs also in having well-marked carinæ on the 7th segment, while all the other segments are smooth, and in the number and proportions of the antennal joints. This latter point is probably due to immaturity, the length of the joints of the peduncle and the number of joints in the flagella increasing with age.

*Integument* (fig. 50).—The whole animal is covered with minute scale-like plates, with pectinate margins.

*Pereon*.—In the young from the incubatory pouch, 2.25 and 3 mm. long, the pereon is perfectly smooth, the dorsal processes and lateral carinæ of the 7th segment being represented by mobile sensory setules, each inset in a little depression of the cuticle. The 7th dorsal process appears to develop first, followed by the 1st, 2nd, and 3rd consecutively, then the 6th and 4th, the 5th being the smallest and the last to arrive. At about 5 mm. length the 7th hump commences as a slight rounding of the margin behind. At 7 mm. it is well developed and elevated as in the adult, and the 1st also can be seen. At 8–9 mm. the hump on the 2nd segment has appeared; and at 10 mm. the 1st, 2nd, 3rd, and 7th are well-marked, and the lateral carinæ of the 7th segment indicated by a rounding of the margin. In only the largest specimens, 11–13 mm., are all seven humps developed; lateral carinæ ending in denticles. The posterior angles of the hinder segments are produced backwards, those of the 7th acute and slightly serrate.

*Side-plates* overlapping considerably. Anterior lobe of the 5th broader than posterior; anterior lobe of 6th very small; 5th and 6th ridged laterally; in the young from the incubatory pouch the lateral ridges are distinctly though faintly indicated; 5th, 6th, and 7th serrate behind.

*Pleon*.—The postero-lateral margins of the first three segments firmly serrate, the serrations turning the corner; segments 1 and 2 more rounded in the female than in the male, the teeth of the lateral carinæ and the serrations downcurved; segment 3 rounded quadrate, evenly serrated, the lateral denticles and the 12–14 serrations upcurved. The 3rd segment in both male and female carries a row of long, plumose sensory hairs, set just under the projecting tooth of the dorsal carina of the 2nd segment. In the young the dorsal carinæ of segments 1–4 are indicated, as also the lateral carinæ of the 3rd, and in the place of the denticles which develop later, minute sensory setules, similar to those of the pereon, are inset. The apices of the telson and of the uropods are likewise provided with these setules.

*Head* about the length of the first two pereon segments in the female, of the first three in the male; rostrum broad and deflexed, not quite half the length of the 1st joint of the superior antenna.

*Eyes* large and prominent, and pyriform in the adult, with numerous small dark ommatidia. In the young the eyes are round; in one specimen, 4 mm., the very dark ommatidia numbered 22, arranged in 5 rows; in another, 8 mm., the shape was a rounded oval, the ommatidia numbering about 80.

*Antennae: superior antenna*, full-grown female.—1st joint of the peduncle not so long as the 2nd and 3rd together; 3rd nearly two-thirds the length of the 2nd; 1st and 2nd with apical teeth. *Primary flagellum* scarcely as long as the peduncle, each joint carrying a calceolus and a long sensory filament; 12-jointed in the largest specimens, 12.5 mm. long, with all 7 pereon-humps well developed, as in fig. 49. In slightly smaller specimens, 11 mm., with the 4th and 5th segment humps minute, the joints of the flagellum numbered 11, while in the smallest 'Huxley' specimen, 10 mm., there were only 10 joints in each flagellum. The *accessory flagellum* consists of 1 small joint with 1 long ciliated hair and 1 sensory cleft seta (fig. 52); the ciliated hair being inset on the under side, much lower than the seta, gives the appearance, when in position, of a minute apical joint.

Male. 'Huxley' specimen, 8.75 mm.—1st joint as long as the 2nd and 3rd together; 3rd not quite half the length of the 2nd. *Primary flagellum* 23-jointed; *accessory flagellum* as in female, tipped with long ciliated hair and 2 cleft setæ. The 1st joint of the primary flagellum is long and broad; the 2nd short; the following 8 successively a little longer and thinner, each with a calceolus and a dense group of sensory filaments (fig. 61) on the inner side; the next 4 joints are alternately long and short, the long ones with a cluster of setæ only, the short ones with a calceolus and sensory filaments. This alternation of long and short joints occurs also in the inferior antenna (cf. also *Eusirus biscayensis*). The remaining 9 joints are of equal length, with clusters of small filaments. The ciliated hairs on the peduncle are remarkable for the great length of the "feathering."

In the Irish specimens, 10 mm., the 1st joint of the peduncle is shorter than the 2nd and 3rd combined; 3rd joint about half the length of the 2nd. The *primary flagella* are all broken, 31 joints remaining on one.

The young in the incubatory pouch has the 1st and 2nd joints subequal in length, the 3rd half as long as the 2nd; primary flagellum of 4 joints not nearly so long as the peduncle; accessory flagellum (fig. 53) 1-jointed, tipped with 2 setæ and 1 sensory filament.

*Inferior antenna*. Full-grown female.—Agrees with Sars' description.

Male. 'Huxley' specimen.—4th joint of the peduncle broader and slightly shorter than the 5th; 3rd, 4th, and 5th posteriorly laminar. The *flagellum* subequal to the peduncle in length, 24-jointed; the first 4 joints each carry a calceolus and a cluster of long setæ; the next 8 are alternately long and short, the short ones with a calceolus and long setæ; the 14th, 17th, 20th, and

apical joint with long setæ, the others with only 3 or 4 small setæ apiece.

The Irish specimens of 8-9 mm. agree with the 'Huxley' one; the sensory filaments and calceoli are developed, though in much less degree than in the adult. The larger males, 10 mm., have the peduncle joints of the inferior antenna as figured by Sars; the 4th joint being three-quarters the length of the 5th, instead of subequal to it, as in the younger animals; flagellum 36-jointed.

In the young in the incubatory pouch the 4th and 5th joints of the peduncle, taken together, much exceed the flagellum in length.

The calceoli are of exactly the same construction as those figured by Bonnier for *R. rostrata*, but with the "cupule" much smaller in proportion to the "tube." They are a character of sexual maturity, appearing simultaneously with the incubatory lamellæ in the female, and with the antennal sensory filaments in the male, and increasing in size and number with the animal's growth.

*Oral parts: upper lip.*—The apex appears to be more produced in the male than in the female; apical margin covered with fine minute hairs, with a cluster of longer ones on either side.

*Mandibles.* Female (fig. 54): *Right mandible.*—*Cutting-plate* greatly curved; margin divided into 8 rounded teeth, with 1 large obtuse tooth above, and 2 very large teeth below. *Accessory plate* tridentate, upper tooth at a different level from the others, as appears usual in this genus. *Left mandible.*—*Cutting-plate* with 1 large tooth above, 7 small rounded ones, and 2 strong incurved teeth below. *Accessory plate* much stronger than that of the right mandible, margin divided into 6 teeth. 5 spines in the *spine-row*, each with a delicate brush-like seta behind. The spines are stout, and being covered with minute spinules, have a downy or furry appearance. *Molar* prominent, the small spines edging the crown of the same construction as those of the *spine-row*; crown surrounded with numerous long fine setæ.

Male.—*Cutting-plates* tridentate below, margin divided into 9 rounded teeth; *accessory plates* as in female. 4 spines in *spine-row* in 'Huxley' specimen, 5 in Irish specimens of 10 mm. length.

The terminal joint of the *palp* is covered on the outer side with a fur-like spinose armature. The margin is bordered with three series of spines; an apical group of 3 or 4, long and setiform; then a group of short, flat, strongly dentate spines (fig. 59), usually 5 on the right palp and 6 on the left; the third series extending along the rest of the margin, containing 18-20 spines of varying length, similar to but smaller than those at the apex (fig. 60). The spines of the 2nd joint are of the cleft-tipped variety, feathered for half their length.

*Maxilla* 1. Female and male.—*Outer plate* with 9 spines set in two rows; 5 with from 1-3 large auxiliary teeth; the other 4 longer, with from 4-12 small teeth (fig. 55). The number of spines

is the same on both maxillæ, but the number of the auxiliary teeth varies. Both plates and *palp* covered with fine hairs.

*Maxillipeds*.—The 2nd and 3rd basal joints with fan-shaped groups of long stout bristles on the outer side. 2nd and 3rd joints of the *palp* each carrying on the inner side a longitudinal row of cleft-tipped bristles and a number of small curved sensory spines, similar to those on the gnathopods; terminal joint in the male ending in a distinct nail.

*Gnathopods*.—Practically no difference between the gnathopods of the full-grown specimens and those figured by Sars. The basal joints in both gnathopods are considerably wider at the distal end; posterior margins convex, densely crowded with small curved sensory spines, with 6-9 longer ones at the distal angle. These spines develop at maturity, together with the calceoli and sensory filaments of the antennæ; young specimens, 4-5 mm., have none; older animals, 8 mm., carry a single row; while in the full-grown specimen the margin is thickly covered with a band of them, one overlapping the other. In the second gnathopod the 4th and 5th joints are produced to a strong denticle at the posterior angle. The curved finger is longer than the palm, the tip fitting into a groove on the inner side of the hand. The feathered spines on the outer side of the palmar margin are shorter and twice as numerous as those of the inner side, and are set in graduated oblique rows, the longest spine of each row the farthest from the margin; those of the inner side are also graduated in size, but set in a continuous line. The curious specialised bristles, characteristic of this family, are to be found on either side of the finger articulation, the dentate one on the outer side, and the plumose on the inner. These bristles are among the first to appear; in a small specimen, 4 mm., both are well developed.

*Peræopods*. Full-grown female.—Agreeing with Sars' figures; sensory armature more complete, as is to be expected. The 2nd peræopod is longer than the 1st; basal joint wider, the posterior margin densely crowded with sensory spines, as in the gnathopods, that of the 1st with only a single row. In the hinder peræopods, the anterior margins of the basal joints are armed with numerous small spines; the 4th and 5th joints carry a row of small deeply inset spines (fig. 56) on the outer side, in addition to the marginal groups, a double row on the 5th joint of the 5th peræopod. The under surface of some of the joints—4th of peræopod 3, 4th and 5th of peræopod 4, and the 4th, 5th, and 6th of peræopod 5—is provided with rows of very delicate, mobile, plumose hairs (fig. 57), about 6-8 in a row; a few scattered smaller ones occur on the basal joints. The terminal joints of all the peræopods are extremely long and slender, the first four with the tip recurved (fig. 62), the fifth with a distinct nail (fig. 63); all carry the long, stiff, feathered seta proximally, longest on the 5th. The 1st and 5th fingers are subequal to each other in length, the 2nd and 3rd a little longer, the 4th the longest.



Male. 'Huxley' specimen.—The basal joints of the hinder peræopods differ from those of the female in having the anterior portion much more produced downwards, forming in the 3rd and 4th peræopods, a large rounded pellucid lobe extending considerably beyond the level of the posterior expansion, and nearly covering the succeeding joint (text-fig. 279). On the under side of these joints is a slight longitudinal expansion setting out at right angles to the joint, and terminating distally in an acute projection tipped with 3 sensory spines, one of great length. The

Text-fig. 279.



*Rhachotropis helleri* Boeck.

Fourth peræopod of the male, showing the anterior lobe of the basal joint.

basal joint of the 5th peræopod is much larger than the preceding, with anterior and posterior lobes at the same level. A ciliated hair is found midway on the hind margin of peræopods 3-5, and peræopod 4 also carries a remarkably long ciliated hair proximally.

*Pleopods.* Male. 'Huxley' specimen.—Rami but little longer than the peduncle in the 1st pleopod, half as long again in the 3rd; coupling-spines large, more dentate on the left pleopod than on the right (see figs. 64, 65). The peduncle of the 1st pleopod

carries a row of 25 delicate plumose hairs along the outer margin; on the 2nd pleopod the hairs are smaller and fewer in number. In the full-grown female the outer ramus has 20 joints, the inner 17; 4 cleft spines on the 1st pleopod, 3 on 2nd and 3rd.

In the young in the incubatory pouch the outer ramus has 4 joints, 1 large and 3 small; the inner ramus, 3 joints, with 1 cleft spine on the 1st. The coupling-spines have the two large upper teeth, but none of the small ones.

*Uropods and telson.*—In the female the proportions are as in Sars' figure. The young male has the inner ramus of the 2nd uropod half as long again as the outer; all the margins pectinate. The telson in the female is cleft for half its length, in the young in the pouch; and in the young males, 8–10 mm., to rather more than half the length. It carries proximally a pair of large, mobile, ciliated hairs, as do most of the *Rhachotropis*; another much smaller pair near the cleft; a submarginal irregular row of sensory spinules; and a setule inset in either apex. Both pairs of ciliated hairs, and the apical setules are to be found in the young in the pouch.

*Distribution.* Kara Sea. Stebbing (38), p. 38.

North Atlantic. Stebbing (37), p. 955.

Norway, S. and W. coasts, 50–100 fathoms. Sars (29), p. 427.

Ireland: "Common on the Atlantic slope off the West Coast of Ireland, at depths from 200–400 fathoms." (Mr. Tattersall, in a letter dated 31. x. 08.)

Bay of Biscay: Taken by the 'Huxley' at Station XII.,  $48^{\circ} 7\frac{1}{2}'$  N.,  $8^{\circ} 13'$  W., August 26, 1908, in 246 fathoms; bottom deposit, fine sand.

Other localities doubtful.

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## EXPLANATION OF THE PLATES.

## PLATE LXXX.

- Fig. 1. Head and antennæ, ♀. *Parapleustes gracilis* Buchholz. × 44.  
 2. Accessory flagellum, superior antenna, ♀. *P. gracilis*. × 28.  
 3. Right mandible, ♀. *P. gracilis*. × 44.  
 4. Left mandible, ♀.                    “                    × 44.  
 5. First maxilla, ♀.                    “                    × 44.  
 6. Second maxilla, ♀.                   “                    × 44.  
 7. Maxilliped, ♀.                    “                    × 44.  
 8. Whole animal, ♀. *Sympleustes grandimanus* Chevreux; actual size 7.5 mm.  
 9. First gnathopod, young ♂, Irish specimen. *S. grandimanus*. × 28.  
 10. First gnathopod, young ♀, ‘Huxley’ specimen.                    “                    × 44.



- Fig. 11. Second gnathopod, young ♀. *S. grandimanus*. × 44.  
 12. Second gnathopod, large ♀. " × 44.  
 13. Second gnathopod, young ♂, Irish specimen. *S. grandimanus*. × 28.  
 14. Finger of first gnathopod, under surface, young ♀. " × 176.  
 15. Finger of first peræopod, young ♂. *S. grandimanus*. × 49.  
 16. " " " " " × 84.  
 17. Finger of third peræopod, young ♀. " × 84.  
 18. Accessory flagellum, superior antenna, young ♀. *S. grandimanus*. × 109.  
 19. Side-plate 4, young ♂. *S. grandimanus*. × 28.  
 20. Upper lip, large ♀. " × 38.  
 21. Lower lip, " " × 50.  
 22. " young ♀. " × 50.  
 23. " young ♂, taken from above to show relative proportions. *S. grandimanus*. × 38.  
 24. Left mandible, large ♀. *S. grandimanus*. × 50.  
 25. Cutting-plate and accessory plate, right mandible, young ♀. " × 176.  
 26. " " " " " large ♀. " × 176.  
 27. " " " " " young ♂. " × 176.  
 28. Right maxilliped, large ♀. *S. grandimanus*. × 85.  
 29. First maxilla, young ♂. " × 50.  
 30. Second maxilla, young ♂. " × 38.  
 31. Second and third uropods and telson, young ♀. *S. grandimanus*. × 50.  
 32. Apices of telson, young ♂. *S. grandimanus*. × 50.

## PLATE LXXXI.

All the figures, except fig. 51, from the 'Huxley' specimens.

- Fig. 33. Whole animal, ♀. *Eusirus biscayensis* Bonnier; actual size 13.5 mm.  
 34. Antennæ, ♀. " × 11.  
 35. Accessory flagellum, superior antenna, ♀. *E. biscayensis*. × 28.  
 36. Antennæ, ♂. *E. biscayensis*. × 11.  
 37. Dorsal outline of 3rd, 4th, and 5th pleon segments, ♂. *E. biscayensis*. × 11.  
 38. Upper lip, ♀. *E. biscayensis*. × 28.  
 39. Lower lip, ♀. " × 28.  
 40. Maxilliped, inner surface, ♀. *E. biscayensis*. × 28.  
 41. Cutting-plate and accessory plate, right mandible, ♀. *E. biscayensis*. × 96.  
 42. Accessory plate, right mandible, ♀. From another specimen. " × 96.  
 43. Tooth from molar, right mandible, ♀. " × 333.  
 44. Cutting-plate and accessory plate, left mandible, ♀. " × 96.  
 45. Uropods and telson, ♀. One side flattened to show the uropods. " × 11.  
 46. Upper lip, ♂. *Rhachotropis rostrata* Bonnier. × 28.  
 47. Cutting-plate and accessory plate, left mandible, ♂. *R. rostrata*. × 50.  
 48. " " " right mandible, ♂. " × 96.  
 49. Whole animal, full-grown ♀. *Rhachotropis helleri* Boeck; actual size 12.5 mm.  
 50. Cuticle from side-plate of first gnathopod, ♀. *R. helleri*. × 176.  
 51. Portion of egg-mass, from young ♀, 10 mm. in length; taken from underneath, to show method of attachment, Irish specimen. *R. helleri*. × 33.  
 52. Accessory flagellum, superior antenna, ♀, with calceolus. " × 125.  
 53. " young specimen from incubatory pouch. " × 50.  
 54. Cutting-plate and accessory plate, right mandible, ♀. " × 96.  
 55. First maxilla, spines of outer lobe, ♂. *R. helleri*. × 176.  
 56. Small sensory spine from under surface of 4th joint, 5th peræopod, ♀. *R. helleri*. × 290.  
 57. Plumose hair, from the same, × 290.  
 58. Sensory seta from distal angle of 6th joint, 5th peræopod, ♀. *R. helleri*. × 176.  
 59. Dentate spine, terminal joint of palp, right mandible, ♀. " × 176.  
 60. Spine " " " " " ♀. " × 176.  
 61. Sensory filament, superior antenna, ♂. *R. helleri*. × 290.  
 62. Tip of finger, 2nd peræopod, ♀. " × 290.  
 63. " " 5th " ♀. " × 176.  
 64. Coupling spines, right pleopod of first pair, ♀, under surface. *R. helleri*. × 176.  
 65. " " left " " " " " × 176.

3. Notes on some Aberrations in Oriental Lepidoptera, and on a new Form of *Euschema* from Sumatra. By Lt.-Col. J. MALCOLM FAWCETT \*.

[Received July 2, 1909.]

(Plate LXXXII. †)

During a fairly extensive experience in collecting Rhopalocera I have not come across a more remarkable example of aberration, or "sport," as such are sometimes called, than the two here described. The cause of these freaks of nature is somewhat obscure; I have even been told that a voyage across the ocean, when in the pupal stage, has been supposed to have contributed in some (unexplained) way to its appearance amongst specimens sent from America to this country; however this may be, it can have nothing to do with the specimens under notice here, as they were taken at Port Blair, in the Andaman Islands, in the perfect state.

The general tendency of the exceptional modifications in their coloration is decidedly towards melanism, which might, to a certain extent, be accounted for by the heavy rainfall during the monsoons in the Bay of Bengal; and yet, in a very large series of each of the two species which I possess, nothing out of the common typical form has turned up, excepting these two examples. The almost indiscriminate conglomeration of the small distinctive spots of the two species into large and comparatively shapeless fuscous streaks and blotches, is such a striking feature in these two specimens that it appears to me to be worth being placed on record.

The descriptions are appended; a reference to a figure of the typical form is given in each instance.

EUTHALIA CIBARITIS. (Plate LXXXII. fig. 5.)

Hewitson (*Adolias*), A. M. N. H. (4) xiv. 1874, p. 358.

De Nicéville (*Tanaëcia*), Butt. of Ind. ii. 1886, p. 223, pl. xix. fig. 77, ♂.

*Description*.—This aberration differs from the typical form on the upper side in the prominent white band being present only on the *fore wing*, much reduced in breadth, pinkish white and infuscated with black atoms. Inside the band the discal spots are lengthened into black streaks in every interspace. The four black lines in the discoidal cell become two black renal spots. *Hind wing*: the black lines in the cell are reduced to renal spots, as in fore wing; no white discal fascia, and the rows of discal black spots lengthened into black streaks in the interspaces.

\* Communicated by Dr. P. CHALMERS MITCHELL, F.R.S.

† For explanation of the Plate see p. 883.



West, Newman chromo





*Under side.* Two black spots in discoidal cells as above; a prominent white spot between the discoidal nervules, and two indistinct and much sullied white spots in the first and second interspaces. The remaining spots of both wings are enlarged into long black streaks between the nervules.

This most extraordinary aberration is a male specimen and was taken at Port Blair.

CETHOSIA NICOBARICA. (Plate LXXXII. fig. 4.)

Felder, Verh. zool.-bot. Ges. Wien, xii. 1862, p. 484.

Bingham, Faun. Brit. Ind., Butterflies, vol. i. pl. vii. fig. 53, 1905, ♂.

*Description.*—This aberration differs from the typical form as follows:—

*Upper side.*—*Fore wing.* The three white elongate lunules which are so prominent a feature in *C. nicobarica* are reduced to three obscure white streaks, the white spot below them much sullied with black atoms and reduced in size; the discal row of white spots outside the afore-mentioned lunules is wanting, and the marginal series of fine white lunules is obsolescent.

The spaces between the black lines in the cell are much infuscated, and there are two large black spots in the first and second median interspaces.

*Hind wing* as in typical form, but the subcostal black spots are enlarged, the discal black spots are almost obsolescent, and the submarginal black spots and lunules are almost obsolete.

*Under side.* Cell of fore wing much infuscated between the lines; no pale discal fascia beyond the cell; the series of lanceolate spots in *C. nicobarica* replaced by a series of small white streaks much sullied with black atoms.

*Hind wing* with the black markings of the two inner bands somewhat enlarged, and without the adjoining white bands; the submarginal series of black spots in a white band obsolete, and its place only indicated by a row of very indistinct and obsolescent yellow lunules.

The specimen is a male taken at Port Blair.

ABERRATIONS OF *PAPILIO CLYTIA*, RACE *PANOPE*.

(Plate LXXXII. figs. 1, 2, & 3.)

Bingham, Faun. Brit. Ind., Butterflies, vol. ii. p. 75 (1907).

*Papilio clytia* Linnæus, Syst. Nat. ed. x. p. 479 (1758).

*Papilio panope* Linnæus, Syst. Nat. ed. x. p. 479 (1758).

*Papilio papone* Westwood, Trans. Ent. Soc. 1872, p. 94, pl. iii. fig. 2.

*Papilio onpape* Moore, P. Z. S. 1878, p. 840.

Three aberrations of *Papilio panope* from the hills east of Tounghoo, Burma, in the writer's collection, are given here:—

No. I. aberration (fig. 1) has the usual buff-coloured spots and

streaks replaced by fuscous of a different colour from the ground-colour of the fore wing, with two very indistinct dark grey subapical spots, and two minute spots of the same colour near the tornal angle of the fore wing. *Hind wing*: the sagittate internervular streaks are whiter and longer than in the normal form.

No. II. aberration (fig. 2) has the fore wing absolutely concolorous; all spots and streaks have become obsolete. *Hind wing*: the sagittate streaks are reduced to a minimum and thickly irrorated with the hair-brown ground-colour. This form would represent the var. *papone* Westw. if it did not entirely lack "the bluish tint in certain lights."

No. III. aberration (fig. 3) has the ground-colour much darker, and similar to that of the form from continental India (true *panope* Linn.), while all the buff-coloured spots and streaks are greatly enlarged. *Hind wing*: the sagittate streaks are similar to those in aberration I.

*Papilio clytia* and *Papilio panope* and their various forms are now considered to be one and the same species, dimorphic in both sexes. It is probable that the various forms have been gradually developed in imitation of the forms of *Danainæ* occurring with them. It is suggested that the presence of *Euplœa alcathoë* in the same locality might be accountable for the disappearance of the usual spots on the fore wing of figures 1 and 2; while, on the other hand, *Euplœa distanti*, with its broad white subapical spots (or, perhaps, in a lesser degree, *Euplœa godarti*), may be the model of the form shown at fig. 3.

#### EUSCHEMA SUMATRENSIS, sp. n. (Plate LXXXII. fig. 6.)

*Habitat.* Sumatra (June 1896).

*Description.*—Head, thorax, and abdomen orange-yellow; a black spot on each tegula; ground-colour of wings Indian red; markings similar to those of Javan specimens of *E. militaris*, from which it differs in being without the lower basal black streak; the black spots in interspaces 2 and 3 of fore wing larger and the spot below the cell of the hind wing smaller, almost obsolescent; it also lacks the black bands across the thorax and abdomen, which are such a prominent feature in that species; inner margin of hind wing orange, fringed with orange hairs.

Some years ago the writer submitted the specimen from which the accompanying fig. 6 is drawn to Sir G. Hampson for identification. At that time (1907) there were no corresponding specimens, or, indeed, anything approaching it more nearly than *E. isolata* (which is a yellow insect), in the British Museum, and Sir George was unable to identify it. When preparing figures for this paper the writer made the accompanying drawing and sent it to Sir George Hampson, who wrote as follows:—"We now have a

specimen from Java halfway between the yellow form (*cuprina* Felder) and your drawing; it is named *Euschema frühstorferi* Röber, yours being evidently an *extreme* form of that species."

Though it may be only an aberration it seems desirable, for convenience, that this form should have a name, so I propose to call it "*sumatrensis*."

#### EXPLANATION OF PLATE LXXXII.

Fig. 1. Aberration of *Papilio clytia*, race *panope*.

- |    |                               |                              |   |   |   |
|----|-------------------------------|------------------------------|---|---|---|
| 2. | Do.                           | "                            | " | " | " |
| 3. | Do.                           | "                            | " | " | " |
| 4. | Do.                           | <i>Cethosia nicobarica</i> . | " | " | " |
| 5. | Do.                           | <i>Euthalia cibaritis</i> .  | " | " | " |
| 6. | <i>Euschema sumatrensis</i> . |                              |   |   |   |

#### 4. Note on the Cetacean *Sotalia borneënsis*.

By R. LYDEKKER \*.

[Received September 29, 1909.]

When describing in the Society's 'Proceedings' for 1901 (p. 88, pl. viii.) an estuarine Dolphin from Borneo, under the name of *Sotalia borneënsis*, I had no information as to the colour of the type-specimen in life, but assumed that this was approximately shown by the skin. In this I was wrong, for I have recently been informed by Mr. Ernest Hose, who saw the specimen alive, that the original colour of the upper surface was pale bluish slate, or slaty blue, and that of the under-parts greyish white. This brings it into much closer connection, so far at least as colour is concerned, with *Sotalia sinensis*, which is described as being cream-coloured with pinkish fins and black eyes. The type-specimen has, however, only  $\frac{32}{32}$  teeth, against  $\frac{36}{34}$  in the Bornean Dolphin, and as the teeth are smaller in the Bornean than in the Chinese specimen, the specific distinctness of the former may, at all events provisionally, be still admitted. I may add that a plaster-model of the type-specimen of *S. borneënsis* preserved in the British Museum (Nat. Hist.) has been coloured from a sketch kindly supplied by Mr. Hose.

\* Communicated by permission of the Trustees of the British Museum.

December 14, 1909.

G. A. BOULENGER, Esq., F.R.S., Vice-President,  
in the Chair.

The Secretary read the following report on the additions made to the Society's Menagerie during the month of November 1909:—

The registered additions to the Society's Menagerie during the month of November were 176 in number. Of these 89 were acquired by presentation, 24 by purchase, 22 were received on deposit, 39 in exchange, and 2 were born in the Gardens.

The total number of departures during the month, by death and by removals, was 199.

Amongst the additions special attention may be called to the following:—

1 Reen Gazelle (*Gazella marica*) from Central Arabia, deposited on November 20th.

1 Uvæan Parrakeet (*Nymphicus uvæensis*) from the Loyalty Islands, deposited on November 9th.

A collection of 35 birds, including 11 Blue Birds (*Sialia sialis*), 2 Red-tailed Buzzards (*Buteo borealis*), 6 Hermit Thrushes (*Hylocichla guttata pallasi*), 4 Wood Thrushes (*Hylocichla mustelina*), and others from North America, received in exchange from the New York Zoological Society on November 18th.

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Mrs. R. Haig Thomas, F.Z.S., exhibited seven skins of Hybrid Pheasants and made the following remarks:—

One of the pheasants exhibited here this evening is rather interesting to students of Heredity. The following is a short account of the pedigree of this bird:—

On March 1st, 1907, two silver hens were mated with a Swinhoe cock. Twenty F. 1 hybrids were reared, thirteen cocks and seven hens.

On January 14th, 1908, the seven F. 1 hens were mated with the same Swinhoe cock, and from these were reared five F. 2 hybrids, four cocks and one hen. It is about this hen I wish to say a few words.

We have plenty of evidence of hens transmitting the cock plumage of their kind to hybrid male descendants, but I am not aware that any record of the converse happening has been published.

The Mendelian theory that the male is a homozygote for sex pure in maleness and the female a heterozygote carrying both sexes in its germ cells, gives us a very clear interpretation of certain recent sex experiments, but it must be admitted that it is difficult to explain on this hypothesis how the Swinhoe cock has handed down to his progeny the exact plumage of the hens of his species. If you compare the F. 2 hen with the pure



Swinhoe and pure silver hens, you will see that is so. Although amongst many birds the plumage of the young male often resembles that of the adult hen of his species, yet in the case we are considering, at no stage of his existence does the Swinhoe cock put on the plumage of the adult hen of his species, and at three months he has already assumed part of the adult male plumage, though he does not appear in the brilliant full dress until the following autumn. As the coupling of plumage and sex is a pretty general rule, these facts seem to point to the Swinhoe cock being possibly a heterozygote for sex.

The following is the method I adopt in my breeding experiments:—

Birds are mated in January in a padlocked pen wired all round and all over, of which only the keeper and myself possess the key. Each pen is numbered and recorded in a book with the number of birds and their species. When gathering the eggs in a pen these are marked with its number and dated before leaving that pen. When the eggs are set under a hen the lid of her sitting box is marked with the number of the pen from which the eggs were gathered, the date of sitting, and number of eggs set. When the chicks are hatched they are placed with the hen in a coop with the pen number painted on it, having a small covered-in run in front so that the chicks can never get away.

At six weeks old the chicks are ringed on the leg: the ring has the year, the number of the pen, and the generation "F. 1" or "F. 2," stamped on it. This year they were also wing-labelled. Records of all these matters are taken down in pencil in a notebook at the pens with date of entry and copied into a large book, a four-year diary.

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Mr. D. Seth-Smith, F.Z.S., the Society's Curator of Birds, exhibited a photograph (text-fig. 280), taken by Mr. W. S. Berridge, F.Z.S., of a nest of *Scopus umbretta*, and made the following remarks:—

A pair of South African Hammerkops or Tufted Umbres belonging to the Society were placed in the Great Flying Aviary last spring, and forthwith commenced to collect sticks and any rubbish they could find with a view to nest-building. They first selected a site about ten feet from the ground on the top of a small kennel-shaped box, originally fixed up as a nesting-box for Laughing Kingfishers. Here they constructed a large platform of sticks which they cemented together with mud and commenced to build a dome-shaped roof over it.

Apparently they came to the conclusion that the site was not a very suitable one, as they left this nest when about half finished and selected another site, this time on the ground inside a small shelter shed some five feet in diameter. They built an enormous dome-shaped nest in this, completely filling up the shed to a height of about two feet six inches. But this did not suit them,

probably from the fact that rats soon discovered in this nest a snug shelter of which they were not slow in availing themselves. The nearly-finished nest was deserted and the roof of the shed next chosen as a site for a third nest.

Here another huge structure, consisting of quite a cartload of sticks and other rubbish, was constructed. But presumably on account of the interference of the Ibises and other birds in the aviary, this was again deserted and a fourth site chosen.

This time a large nesting-log, fixed twenty feet from the ground in the fork of a dead, ivy-covered tree, was chosen as a base on

Text-fig. 280.



Nest of *Scopus umbretta* in the Society's Gardens.

which to construct the nest. From the time it was commenced it appeared to be complete in about six weeks, but the birds continue daily to add to it. It is composed of sticks, cemented together with mud. It measures four feet in diameter, is about three feet in height, and the single compartment has an inside diameter of nearly two feet. The entrance hole is five inches in diameter. Curiously enough, so far as I am aware, no eggs have been laid by these birds, although they have been nest-building throughout the whole of the summer and autumn and have frequently paired.

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Dr. H. B. Fantham, F.Z.S., Protozoologist to the Grouse Disease Inquiry, exhibited microscopic preparations and sketches







C. W. Andrews. photo.

Bale & Danielsson. L<sup>14</sup>

ROBBER CRABS (BIRGUS LATRO) CLIMBING A SAGO-PALM.



based on his original observations, illustrating the life-cycle of the Protozoön, *Eimeria* (*Coccidium*) *avium* Silvestrini and Rivolta—also known as *Coccidium tenellum* Railliet and Lucet—a Sporozoön parasitic in the alimentary canal of Grouse. The parasite produces a fatal intestinal coccidiosis in Grouse chicks, especially during the first month or six weeks of their life. The immediate effect of coccidiosis in Grouse chicks is enteritis accompanied by diarrhœa, and a similar disease in Fowl chicks is known among poultry-men as “white diarrhœa” or “white scour.”

The life-history of a *Coccidium* may be divided into two cycles: ( $\alpha$ ) asexual multiplication, or schizogony, for the purpose of increasing the numbers of the parasite within the host, ( $\beta$ ) sexual reproduction, or sporogony, for the purpose of infecting fresh hosts by means of resistant spores adapted for extra-corporeal existence. Schizogony and sporogony occur in both the duodenum and cæcum of the Grouse chicks, causing great destruction of the epithelium of the gut. The merozoites, or daughter parasites produced during schizogony, are arranged “en barillet,” like the segments of an orange, within the epithelial cells. A thin cyst wall is secreted precociously around the oval macrogamete ( $\text{♀}$ ) while still within the epithelial cell, leaving a micropyle for the entry of the microgamete ( $\text{♂}$ ) later.

The cæca of Grouse chicks dying from coccidiosis are full of oval spores (oöcysts), which are passed out with the cæcal droppings, forming a source of infection on the moors. Each oöcyst gradually develops four sporocysts within itself, while still in the cæcal droppings, and each sporocyst ultimately contains two sporozoites. On the ingestion of the spores by other Grouse, the sporozoites are liberated by the action of the pancreatic juice of the new host, and proceed to penetrate the epithelium of its gut-wall.

Larvæ of *Scatophaga*, found in Grouse-droppings, swallow the Coccidian spores and void them uninjured, thus aiding in the dissemination of the spores in nature. Coccidian spores are very resistant to varying conditions of weather and, being light, are easily blown about by the wind, so that the moors are being constantly contaminated during an epizootic of coccidiosis.

The coccidiosis of Grouse is transmissible directly to young fowls and young pigeons by feeding these birds on food mixed with fæces of infected Grouse. Adult Grouse are much less susceptible to coccidiosis than immature birds.

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Dr. C. W. Andrews, F.R.S., F.Z.S., exhibited an enlarged photograph (Pl. LXXXIII.) of the Robber Crab (*Birgus latro*) on Christmas Island, and communicated the following account of its habits:—

It is somewhat remarkable that although the Robber or Coconut Crab (*Birgus latro*) has been known for some centuries and

its habits described by numerous observers, there is still considerable doubt and difference of opinion concerning it. This uncertainty probably arises from two causes—first, that the habits of this animal do actually differ considerably in different localities, and, second, that the unreliable reports of natives have often been accepted as authentic. The chief point on which observers differ is whether this Crustacean can or cannot climb trees: thus Chun (Aus den Tiefen des Weltmeeres (1900), p. 414) states that the natives of Diego Garcia say they never have seen it do so, but since on the same authority, it is stated that these crabs carry coconut shells of sea-water with them into the woods, it does not seem necessary to attach much importance to their tales. On the other hand, most observers agree that *Birgus* can and does climb palm trees, and that this statement is correct is proved by the photograph taken by me in Christmas Island, showing two crabs actually on the trunk of the native Sago-palm (*Arenga listeri*): the upper one is ascending and the lower descending. Numerous other individuals are seen round the foot of the tree, taking advantage of the fruit dropped by their more enterprising companions which have ascended in search of it.

In climbing, the large claws are scarcely used at all, the animal clinging to the tree trunk by the sharp points of the walking legs; by the same means nearly vertical faces of rock, where there is apparently little foothold, can be ascended and descended.

Although there is no doubt that these crabs can and do feed on coconuts when they can get them, these are by no means their only food as would seem to be implied by some accounts. In Christmas Island during my first visit (1897–8) there were no bearing coconut palms so far as I was aware, and though there may have been a few on one small beach on the east coast, these could only have supplied food for a few individuals. The ordinary food included fruits of various kinds, particularly those of the Sago-palm (*Arenga listeri*) and of the Screw-pines (*Pandanus*), and carrion of all sorts, even the bodies of their own relations. Their discrimination is not very keen, for they will drag away almost anything that has been handled, such as cooking utensils, bottles, geological hammers, and clothes. In one case I had a geological hammer practically ruined by having its handle splintered in the powerful claws of one of these creatures.

It is usually stated that *Birgus* is nocturnal in its habits, and probably this is usually the case, but in Christmas Island they move about the forest and feed even in the brightest daylight (as is shown by the photograph). Formerly, when the native rats swarmed in the forest after dark, the crabs moved about comparatively little at night, and might often be seen clinging to the trunk of a tree two or three feet from the ground. Now, the rats having become extinct, the crabs wander about at night and are a great nuisance, dragging from the camp anything they can get hold of that seems edible. On one occasion I saw a large individual carrying off a coconut from which the husk had been

removed; it held the nut under its body with some of its walking legs while it walked off raised high on the tips of the others.

These animals are easily frightened and scuttle off backwards, propelling themselves with their long anterior legs in a series of ungainly jerks. They seem quite conscious of the comparative defencelessness of the abdomen, which they endeavour to thrust under logs or into holes among the roots of trees. They never carry any protective covering on the abdominal region, although in the Cambridge Natural History (vol. iv. p. 174), it is stated that they may sometimes employ an empty coconut shell for this purpose. No authority is given for this statement, nor does there appear to be any reference to it in previously published accounts, and from what I have seen I should think that the thing is an impossibility. A species of *Cænobita*, a closely allied genus, has been described as using a coconut shell for this purpose, and a figure of it carrying one is given in Prof. J. S. Gardiner's 'Fauna and Geography of the Maldive and Laccadive Archipelagoes,' vol. i. p. 69; probably this has been confused with *Birgus*.

The photograph now reproduced (Pl. LXXXIII.) has been exhibited in the Natural History Museum (South Kensington) for some time, but as there still seems to be some doubt as to the climbing habits of these crabs, it has been thought desirable to publish it.

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Dr. R. T. Leiper, F.Z.S., exhibited the original specimens of the Nematode Worm *Acanthocheilonema dracunculoides* Cobb., from the Museum of the Royal College of Surgeons. The characters of the genus, of which this is the type, he stated to have been inaccurately interpreted, the posterior end of the worm having been described as the head and the cuticular caudal appendages regarded as "lips." The remarkable specific characters—viz., the entire absence of male forms and the lack in the female of vaginal opening—had also to be repudiated, for both are to be seen in the original material. The genus, as revised, would admit a second species, the *Filaria perstans* of Man.

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The following papers were read :—

1. On Change of Colour in a Specimen of *Mellivora ratel* living in the Society's Gardens. By Dr. F. D. WELCH, F.Z.S.

[Received October 14, 1909.]

There is living in the Society's Gardens at Regent's Park a male Ratel which has been mentioned by Mr. Pocock in the Proceedings of the Zoological Society, 1909, p. 397, when referring

to *Mellivora cottoni*, and the history of this animal during the last twelve years is interesting.

I have had this animal under observation during that period, and it is now very different from what it was when first observed. The change I have noticed is, in Mr. Pocock's opinion, as well as my own, worth recording, especially as Mr. Pocock does not remember the colour of the animal twelve years ago, and also as no skin in the Natural History Museum, South Kensington, shows the same coloration. The skins there examined by myself are twenty-six from Africa and South Arabia, and three from India, and I have also seen five living animals from Africa and Arabia, not one of these showing the colour of the aged male *Mellivora*.

Also I have some remarks to make on this specimen and on *M. indica*, which Mr. Pocock has omitted, as regards the locality from which it came, and some notes on skull measurements.

The animal arrived at the Gardens in 1890 and was apparently full-grown according to the keeper who first saw it, and is thus over twenty years old, and the change in it in my opinion is due to senility, as suggested by Mr. Pocock.

When I first knew it twelve years ago its colour was as follows:—Scalp, back of neck, and dorsal surface were very pale grey with a few black hairs scattered at intervals over the posterior half of the back, no black hairs whatever on scalp, back of neck, and anterior half of back; this dorsal patch of grey was very sharply defined from the black of the under parts by a straight, very distinct line. Tail was quite black on upper and under surfaces, as I shall remark on later.

It was then as large as now, and much larger than a female *Mellivora ratel* which lived with it many years and was adult.

It retained its original colour, not altering in any way till the beginning of 1907, when the pale grey dorsal patch commenced turning black, the change being very gradual and evenly distributed over the posterior half of the back and not in patches, and later on spreading to the anterior half of the back and neck.

This change went on very gradually, the well-defined margin of the dorsal grey patch at its junction with the black of the under surfaces and limbs and tail becoming gradually lost; the black of the under surfaces, limbs and tail becoming gradually continuous with the new black of the back, leaving only scattered grey hairs mixed with black where formerly there was the well-defined line of all grey hairs.

At present all the back is "black merely sprinkled with grey," as Mr. Pocock remarks, but on the scalp there are more grey hairs in proportion to black than on the body, and the black of the dorsal surfaces cannot now be distinguished from the black of the under parts, all black being equally dark in colour, while the dividing line at junction of grey and black, formerly so distinct and continuous, is now broken up and ill-defined.

Mr. Pocock has suggested senility as the cause of this change,



and as the animal is otherwise in good health, I do not think there is any doubt on this point.

The locality of this specimen is unknown, but from my examination of the skins of *Mellivora indica* in the Natural History Museum, from Nepal, Rajpootana and Hoshangabad, Central Provinces, I am of opinion that this specimen came from Africa or Arabia, and judging from its appearance twelve years ago it is a *Mellivora ratel*. The *M. indica* skins above mentioned have the upper surface of the tail white continuous with the dorsal pale area, whereas this specimen twelve years ago had the tail all black (see description above).

Also this specimen is much larger than another male *Mellivora ratel* from S. Arabia living with it, and also adult, and from measurements of skulls of *M. indica* and *M. ratel* taken by myself in the Natural History Museum, apparently *M. ratel* varies considerably in size, much more so than *M. indica*.

This specimen, as already stated, is of the large variety of *Mellivora ratel*, and according to the living material seen by myself and measurement of skulls as given below, there is in this species considerable range of size, which in my mind raises the question as to whether the skins hitherto regarded as *M. ratel* may not be divisible into two species differing only in size. However, most of the skulls have no sex stated, so no definite conclusion can be come to on this latter point, as the male would be naturally larger than the female skulls.

*Skull measurements (from adult skulls).*

<i>M. ratel.</i>			<i>M. indica.</i>		
Male.	Grahamstown...	13·5 cm.	Female.	Rajpootana...	11·5
Male.	Somali.....	12·5	No sex.	Nepal .....	12·7
Female.	Somali.....	10·7	No sex.	Nepal .....	12·7
Female.	Suakin.....	10·5	No sex.	N.W. Provinces	11·6
Female.	Suakin.....	11·7			
No sex.	Khartoum .....	13·1			
	Abyssinia .....	12·0			
	Somali.....	11·4			
	Suakin.....	12·7			
	Aden .....	11·6			
	Aden .....	11·3			
	Kilimanjaro ...	13·1			

Measured from central incisor tooth to anterior margin of foramen magnum.

[So far as can be seen in the living animal, the hairs are either all black throughout or all grey throughout, and not variegated, *i. e.* half black and grey. The black hairs are equally dark in their whole length. Recently the animal has lost a large patch of hair off the back of the neck.—F. D. W.]

2. A Comparative Examination of three living Specimens of  
*Felis tigris sondaica*, with Notes on an old Javan Male.  
By Dr. F. D. WELCH, F.Z.S.

[Received October 16, 1909.]

In the Society's Gardens at Regent's Park is a young male Sumatran Tiger, about which Mr. Pocock made some remarks in December, 1908 (P. Z. S. 1908, p. 890).

Since then I have seen two other living specimens of *Felis tigris sondaica*, one younger and one older than the Society's male, and as my old male shows peculiarities about the neck and ears which I have never seen in any other race of Tiger living or dead, including living examples of both Persian and Manchurian races, a few remarks on the three animals, which were at very different ages, may be interesting, especially as I can find no skins of *Felis tigris sondaica* in the Natural History Museum, and as Mr. Pocock informs me he has had no opportunity of seeing other Tigers of this race, except the one he described.

Elliot in his 'Monograph of the Felidæ' makes statements about the distribution of white on the face which do not agree with the three specimens I have seen, whilst all information I can find about this race, with the exception of Mr. Pocock's remarks, is extremely scanty and vague.

My specimens are an old male from Java which lived in Antwerp for eight years and was estimated to be four years old on arrival, and a female from Sumatra about a year and a half old.

Writing last December Mr. Pocock stated that the Society's male had "shorter hair on the cheeks and throat" than a Persian Tiger, but since then this animal has developed large cheek-tufts and a well marked beard, the cheek-tufts having white on their lower and anterior surfaces and the beard being almost all white. In my old Javan male these cheek-tufts and beard were very large and well developed, and also in the young Sumatran female they were well marked, which shows that *Felis tigris sondaica* grows these at an early age in life.

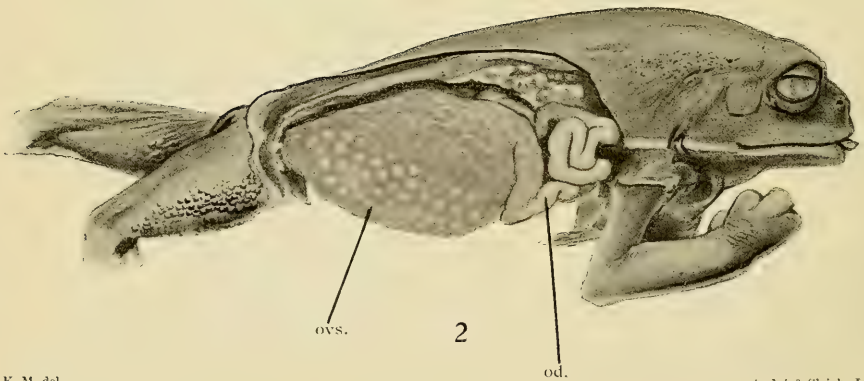
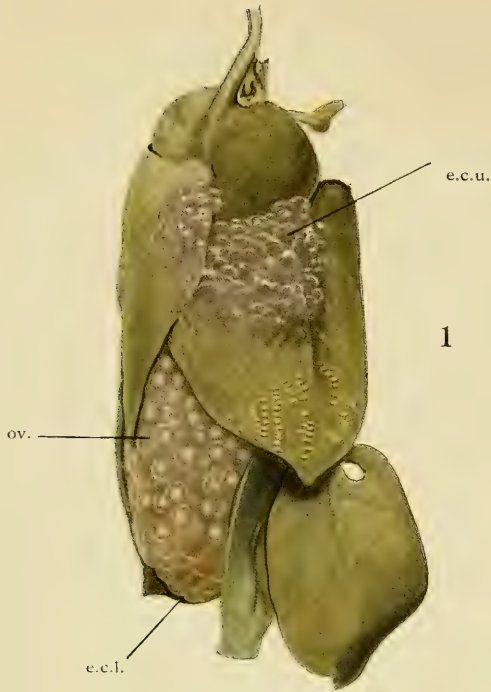
When Mr. Pocock wrote, the Society's male had not the cheek hairs and beard so well developed as now, as it was then in poorer condition, but from its condition now and from the cheek-tufts and beards of my two specimens, I should certainly say that *Felis tigris sondaica* was better developed in these points than the Persian race.

My old Javan male had long and large tufts of hair growing from the internal surfaces of the external ear, and projecting at least three inches beyond the skin of the edge of the ear, and on front view these tufts gave the animal an appearance somewhat similar to that of an Eared Owl.

These tufts are much larger and quite unlike anything I have seen in either the Manchurian or the Persian race.

Also the hair down the back and sides of the neck was very





A. K. M. del.

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1. NEST OF PHYLLOMEDUSA SAUVAGII.

2. P. SAUVAGII, ♀. DISSECTED FROM THE SIDE.



long, forming a long and loose mane, the hairs being quite five inches long, and this mane terminated suddenly at the junction of the neck and body.

The hairs down the throat between the head and fore limbs were also very long, quite four inches. On body and limbs my Javan male had no longer hair than the Society's male, and both my animals had the white on cheek-tufts and beard as I have described in the Society's male.

I may remark that both my animals were as thickly striped on the body as the Society's male, which is a point of interest, as Elliot in his 'Monograph of the Felidæ' says that this race is striped as in the Indian race.

Mr. Pocock has pointed out, when remarking on Nepal specimens, that the presence or absence of a few stripes is of no subspecific value, with which statement I think all accurate observers will agree; and judging from a female I saw from North Persia, I think that if a large number of skins were examined, the Persian race as a whole would not be found to be more thickly striped than *Felis tigris sondaica*.

These observations were from stuffed skins and living animals seen by myself, and not from descriptions by other people or from figures of either race. The living specimens were compared with one another within seven days.

### 3. The Nesting Habits of the Tree-Frog *Phyllomedusa sauvagii*. By W. E. AGAR, M.A., D.Sc., Glasgow University\*.

[Received October 16, 1909.]

(Plate LXXXIV.†)

I give here a few notes on the remarkable nesting-habits of a Tree-Frog, *Phyllomedusa sauvagii*, which I found breeding in great abundance in the Paraguayan Chaco from October 1907 till February 1908‡. This frog, like other members of its genus (e. g. *P. jheringii*, *P. hypochondrialis*), makes a nest suspended from bushes, etc. overhanging a pool into which the tadpoles drop when they are hatched. The nest of *P. sauvagii*, however, differs in a noteworthy way from those of the other species of the genus which have been described.

From the examination of the structure of fully formed nests (Pl. LXXXIV. fig. 1), one of which was found half finished, the female still being engaged in adding eggs, the method of oviposition can easily be deduced. First, the lower ends of a number of leaves are drawn together and held so by a deposit of

\* Communicated by G. A. Boulenger, F.R.S., V.P.Z.S.

† For explanation of the Plate see p. 896.

‡ The observations were made in the course of a zoological expedition to the Chaco, the expenses of which were defrayed by the Government Grant Committee of the Royal Society and by the Managers of the Balfour Fund at Cambridge University.

*empty*, gelatinous egg-capsules, forming together a stiff jelly. These egg-capsules are of course secretions of the oviduct. They are little solid spheres of jelly, made polygonal by mutual pressure, and except that they are a little smaller are exactly like the capsules laid later and containing eggs.

As the act of oviposition continues, egg-containing capsules begin to appear among the eggless ones, and the bulk of the nest is filled with a mixture of full and empty capsules in about equal numbers. Finally, as oviposition approaches its end, the egg-containing capsules become fewer and fewer, and the last addition to the nest is a mass of empty capsules as at the beginning of the process.\*

In order to confirm this view as to the way in which the mass of spawn is made up, which was deduced from examination of a number of nests, I made a dissection of a frog which I had preserved in the act of oviposition, when the nest was about half filled. The dissection (Pl. LXXXIV. fig. 2) shows precisely the conditions to be expected from the structure of the nests. Each ovisac contains a mass of encapsuled eggs and empty (*i. e.* eggless but solid) capsules. The former occupy the postero-ventral and the latter the antero-dorsal portion of the ovisac, but the line of demarcation between the two is not precise. A glance at the figure will show that at the moment when the frog was preserved (in the middle of oviposition) it was laying a mixture of full and empty capsules, but as oviposition continued the proportion of full to empty ones would become less and less, and finally it would be laying empty ones only. The contents of the ovisac of the other side are arranged in a precisely similar way.

The mass of spawn when finished is thus largely, or often even mainly, made up of empty capsules. The egg-containing capsules are embedded in the mass in such a way that in well made nests, such as the one figured, not a single egg is exposed to the light and air, the jelly plug of empty capsules at the top and bottom, and the leaves at the sides forming a complete shield for them.

Each egg is of course enclosed in a vitelline membrane as well as the gelatinous oviducal envelope. As the time for hatching approaches a large quantity of fluid accumulates inside the vitelline membranes, causing them to swell up to twice their proper size and giving the embryos room to make violent movements within the membranes and to give free play to their large external gills, which may be seen moving to and fro.

The fluid inside the vitelline membranes has evidently been extracted from the jelly of the oviducal envelopes, both of those surrounding eggs and of the empty, solid ones; for whereas in the newly laid egg-mass each vitelline membrane fits close round its egg, and is separated from its neighbours both by its own and their own thick oviducal capsules, and also by the empty capsules

\* In the figure some of the leaves have been turned aside to expose the egg-mass. In its natural condition none of the eggs were visible, only the mass of empty capsules at the top and bottom being exposed.

distributed among the egg-mass, at the time of hatching the relatively enormously distended vitelline membranes fill a far greater bulk of the nest, and the jelly capsules between them are reduced to an insignificant remnant.

When about to hatch the tensely filled membranes burst at the slightest touch, liberating both embryo and fluid. If a nest is opened soon after the eggs have hatched, it presents a seething mass of tadpoles wriggling about in a thick mucilaginous fluid, formed by the clear liquid from the burst vitelline membranes and the now dissolved remains of the jelly, in the interior of a chamber the sides of which are formed by leaves, and the floor and roof by the plugs of empty capsules.

In order that the larvæ should reach the water beneath them it is necessary that the wall of this chamber should give way somewhere. The fluid above has a softening effect on the gelatinous floor of the nest, and this gradually softens. At a period of about 12-24 hours after the bulk of the larvæ are hatched (there seems to be about a day's interval between the hatching of the first and last larva) a thick mucilaginous drop may be seen to form at the bottom of the nest, and presently there is a steady drip of the deliquesced jelly plug into the water below. After a few minutes a larva slips through and falls into the pond beneath. A few seconds later two or three more come through in the same way and then they come faster and faster as the whole semi-fluid contents of the nest continues falling drop by drop into the water, taking the larvæ with it. One nest, in which I watched the whole process, took five minutes to empty itself, in which time over 300 tadpoles fell from it into the water.

It sometimes happens that a nest is hung a few inches from the edge of the water. In this case the tadpoles suffer no inconvenience from falling on the dry earth, but being extremely agile quickly flick themselves into the water. Budgett mentions this happening in *P. hypochondrialis* also.

The larvæ, like the aquatic young of so many other vertebrates, exhibit a retraction of their chromatophores at night and an expansion in the daytime.

The most interesting feature of this process is the part played by the empty egg-capsules, which may be said to be three-fold.

First,—The plugs at the top and bottom of the nest provide shields from the sun and air for the eggs, where the leaves do not protect them. The eggs are quite unpigmented, and any that are exposed to the surface, as happens often in less perfectly formed nests, turn yellow and die.

Secondly,—The empty capsules mixed with the full ones in the body of the nest provide an extra source of fluid for the developing embryo, and for the newly hatched larva, as already described.

Thirdly,—The plug at the bottom serves to keep the whole nest intact, until the rather diffuse process of hatching is completed, and all the larvæ are ready to fall into the water.

The large number of empty capsules mixed with the full ones

is very striking, and still more so is the definite arrangement of the proportions in which they are produced in different periods of oviposition. We must suppose that at the beginning of the process the oviducts secrete a large number of capsules before the eggs begin to pass down them, and again at the end must continue to do so after the last egg has passed. The actual production of empty capsules is only what may be found, though to a very much smaller extent, in probably any Anuran. If a batch of *Rana temporaria* spawn be looked over, a few empty capsules—perhaps 2 or 3 per cent.—will generally be found. *P. sauvagii*, however, has developed this peculiarity to an enormous extent and also controlled it in the way we have seen.

The nests are not always so perfect as the one figured. Often gaps are left between the edges of the leaves, exposing some or many of the eggs to the light. Such exposed eggs if they are near the surface die. Sometimes also the jelly plugs at top and bottom contain a few eggs. Such eggs, being exposed, also die. It is significant that the actual percentage of eggs hatched is thus greater in perfect nests than in the less perfect ones often found, for we see that the advantage in productivity of the frogs which make the best nests—*i. e.*, frogs in which the oviducts secrete a sufficient number of empty capsules, especially at the beginning and end of oviposition, and which also make the best use of the leaves to cover the sides of the nest—must tend to perfect the process.

The question of how rounded egg-capsules are formed without eggs as nuclei to form round, is one to which I have not found any clue by the dissection of the oviducts, which were nearly empty in both females I opened. I can only say that I found empty capsules far up in the glandular portion of the oviduct, as well marked off from one another as in the ovisacs.

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J. S. BUDGETT.—“Notes on Batrachians of the Paraguayan Chaco.” Quart. Journ. Micro. Sci. vol. xlii., 1899.

#### EXPLANATION OF PLATE LXXXIV.

Both the figures were drawn from preserved specimens by Mr. A. K. Maxwell. They are of natural size.

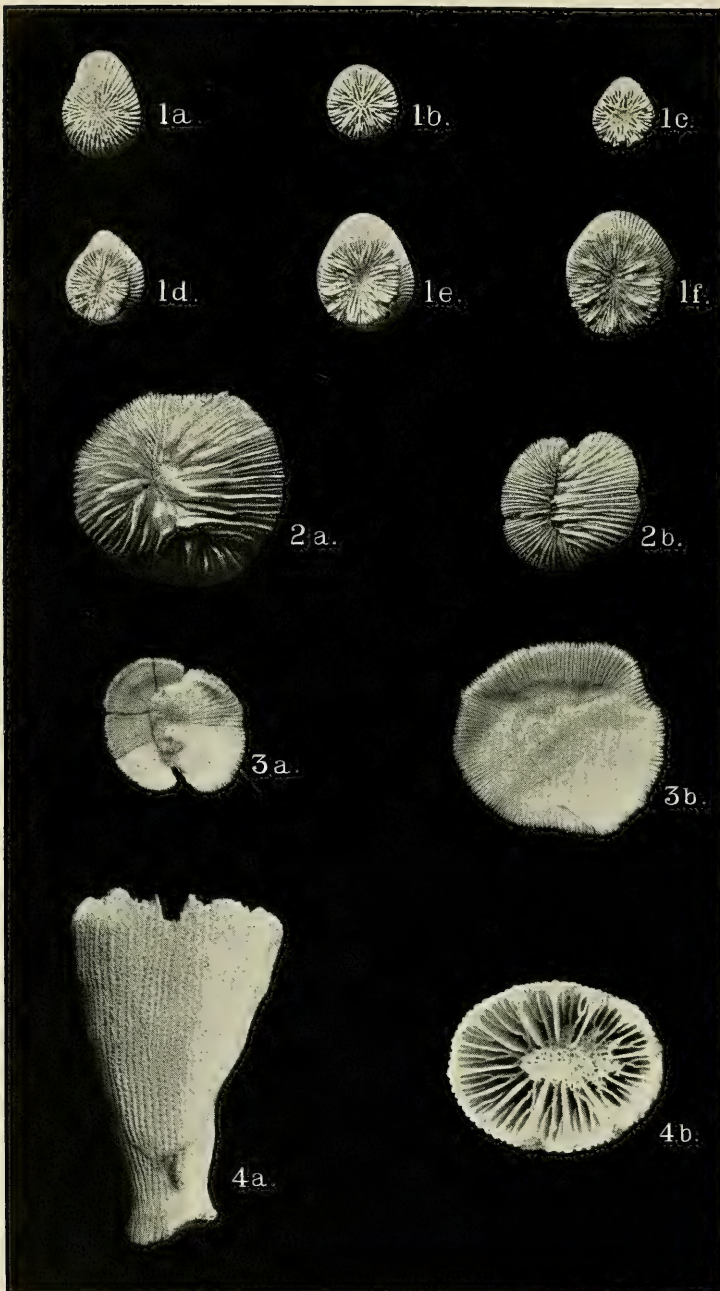
Fig. 1. A nest of *Phyllomedusa sauvagii*. It is hanging in its natural position. Some of the leaves have been turned aside to expose the egg-containing portion of the mass of spawn. *e.c.l.*, mass of empty egg-capsules, forming the bottom of the nest. *e.c.u.*, empty capsules forming the roof of the nest. *ov.*, egg-containing portion of the mass of spawn.

Fig. 2. Dissection of a female *P. sauvagii* preserved when it had about half filled its nest. *od.*, oviduct. *ovs.*, ovisac, containing full and empty capsules arranged as described in the text.

[While the above was in the press, I have seen M. Siedlecki's



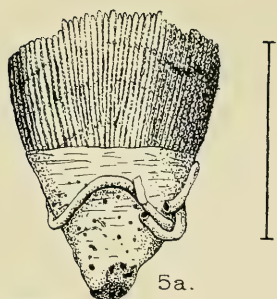




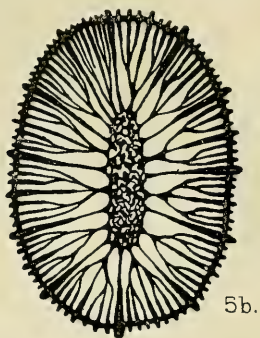
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MADREPORARIA FROM MERGUI ARCHIPELAGO.

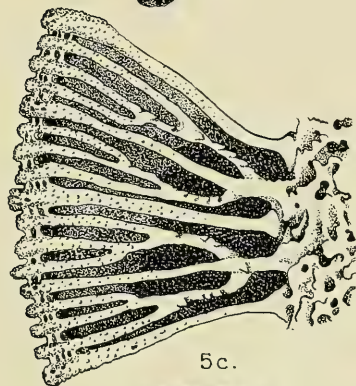




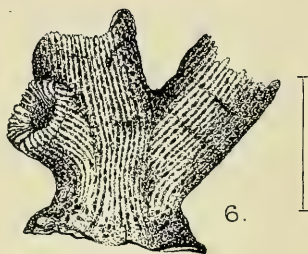
5a.



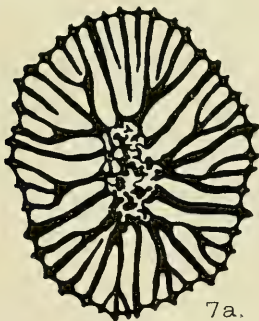
5b.



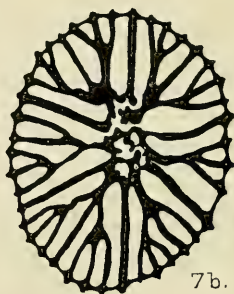
5c.



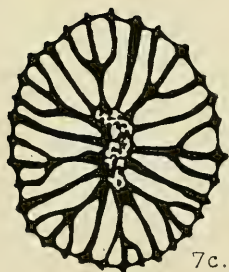
6.



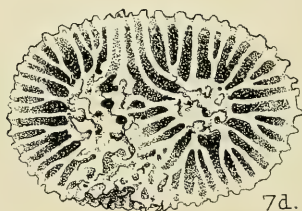
7a.



7b.



7c.



7d.

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paper "Zur Kenntnis des javanischen Flugfrosches," in the Biologischen Centralblatt, Bd. xxix., Nov. and Dec. 1909, in which he describes the nesting-habits of *Polypedates reinwardtii*. These present some interesting points of comparison with those of *P. savagii*. The general economy of the nests is the same, but in *Polypedates* the protection for the eggs and the source of fluid for the developing embryos are supplied by a stiff foamy substance instead of by empty egg-capsules (though Siedlecki states that empty egg-cases are often laid). This substance is distinct from the oviducal egg-membranes, which are embedded in the frothy mass, the whole being suspended in leaves as in *Phyllomedusa*. The majority of the eggs are in the centre of the mass, the outer layers containing comparatively few eggs. It is the foamy substance which appears to give up its water to the developing embryos, like the empty egg-cases in *P. savagii*. After hatching, the tadpoles remain for twenty-four hours or more in the fluid thus obtained, which now lies in the interior of the hollow nest formed by the dried outer layers of the frothy mass. The tadpoles are finally freed by the giving way of the wall of the nest under the softening influence of the fluid inside, or of rain, or of both.—Jan. 1910.]

4. Marine Fauna from the Mergui Archipelago, Lower Burma, collected by Jas. J. Simpson, M.A., B.Sc., and R. N. Rudmose-Brown, B.Sc., University of Aberdeen: MADREPORARIA. By RUTH M. HARRISON and MARGARET POOLE\*.

[Received October 19, 1909.]

(Plates LXXXV. & LXXXVI.†)

The collection was made during the spring of 1907, and entrusted to us for identification and description by Professor Bourne. It contains one species of Turbinolidæ, one species of Flabellidæ, two species of Fungiidæ, and ten species of Eupsammiidæ including one new species of *Balanophyllia*.

We wish to take this opportunity of thanking Dr. Bourne for much help and advice, Professor Herdman for the loan of two species of *Balanophyllia*, and Professor Jeffrey Bell for permission to examine the Eupsammiidæ in the National Collection; also Dr. E. H. J. Schuster and Mr. Robinson for the photographs on Plate LXXXV.

Family TURBINOLIDÆ Milne-Edwards & Haime.

By MARGARET POOLE.

The collection contains 84 specimens of superficially very different appearance, but Gardiner has recently shown [16] that

\* Communicated by Prof. G. C. BOURNE, D.Sc., F.Z.S.

† For explanation of the Plates see p. 912.

we are really dealing, not with several, but with a single species which is highly variable.

Genus *HETEROCYATHUS* Milne-Edwards & Haime.

*HETEROCYATHUS* *ÆQUICOSTATUS* Milne-Edwards & Haime [24].  
(Plate LXXXV. figs. 1 a–1 f.)

*Stephanoseris rousseaui* Milne-Edwards & Haime [27].

*H. philippinensis* Semper [34].

*H. parasiticus* Semper [34].

*H. pulchellus* Rehberg.

*H. oblongatus* Rehberg.

*H. æquicostatus* Gardiner [16].

The above list of synonyms of *H. æquicostatus* is due to Gardiner [16], with the exception of *Stephanoseris rousseaui* which was subsequently added by Bourne [5].

The specimens fall into three main types, of which two are identical with those described and figured by Gardiner [16]; while the third is rather markedly different and resembles more closely the figure given by Semper of his now abolished species *H. philippinensis*. The accompanying photographs (Pl. LXXXV. figs. 1 a–f), however, show that this type is connected with the second type of Gardiner by beautifully intermediate forms.

All the specimens are free with smooth bases, and have the aperture of the Aspidosiphon chamber well at one side and often on a slight protuberance.

Type I. 49 specimens. The corallum is pear-shaped,  $14.5 \times 10.5$  mm. and 6 mm. in height. Lateral pores are confined to the basal surface. The costæ are equal in number to the septa, very clearly defined and extending well round on to the basal surface. They are closely covered with small granules. The septa form four cycles of six systems; the primaries and secondaries are the largest and equal in size, the quaternaries come next in size, the tertiaries being the smallest. Crenulated pali stand before all the septa except those of the third cycle, and are indistinguishable from the inner edges of the septa on one hand and from the columellar trabeculae on the other. Both pali, trabeculae and septa are covered with spiniform granules. The calicular fossa is hardly 1 mm. in depth, and  $2 \times 3$  mm. in diameter owing to the crowded pali.

Type II. 22 specimens. The corallum is pear-shaped or round, of the same size as type I., but generally slightly taller, 8 mm. The lateral pores are distributed in an irregular manner round the lower part of the wall of the corallum and not restricted to the base as in type I. Costæ as in type I., but tending to be less regular in size. The septa are in four cycles of six systems, but here the primaries are clearly marked off from the secondaries by their greater prominence and larger size, and form, together with their adjacent quaternaries, a well-defined six-rayed star, alternating with the points of which the secondaries with their

quaternaries form a similar though less conspicuous figure. The third cycle is here also the least developed. There are three crowns of pali, which are usually well marked off from the septal margins and the columellar trabeculae; both pali and trabeculae are covered with spiniform granules. The columella lies well below the calicular margin, so that in this type there is a distinct though narrow fossa. Intermediates between types I. and II. show less obvious star figures, and the gradual reduction of the pali and consequent development of the well-defined calicular fossa.

Type III. 13 specimens. The corallum is oval or round, 15 mm. in diameter and 10 mm. high, and somewhat compressed in the middle. The lateral pores form an irregular ring a little below the calicular margin. The costae are as in the two previous types. The septa form five cycles of six systems, of which the primaries and secondaries are very much exsert round the margin and the remaining cycles of about equal size, except those members of the fifth cycle on either side of the primaries and secondaries which are slightly enlarged. There are four crowns of nodular pali clearly marked off from the septa and standing well above the trabecular columella; all are ornamented with spines. The fossa is large,  $5 \times 3$  mm. and 2 or 3 mm. deep. Intermediate forms connecting this type with type II. have an incomplete fifth cycle of septa, or all the quaternaries are very much reduced so as to be hardly visible.

*Localities.*—All three types occur at Station XXX. Fly Island, Observation Island, and S.W. of Domel Island. Bottom: rock and sand. Depth: 8–15 fathoms. 48 specimens of type I., 18 of type II., 7 of type III.

Station XXXIII. Christmas Island Group. Bottom: rock, sand, and mud. Depth: 8–23 fathoms. 1 specimen of type I.

#### Family FLABELLIDÆ Bourne [5].

In the present collection there are 29 specimens of the genus *Flabellum*, which, since Gardiner's [15] revision of the group, can all be included in the highly variable species *F. rubrum*.

#### Genus FLABELLUM Lesson.

FLABELLUM RUBRUM Quoy & Gaimard.

*F. variabile* Semper [34].

*F. stokesi*

*F. oweni*

*F. aculeatum*

*F. spinosum*

*F. debile*

*F. sumatrense*

} Milne-Edwards & Haime [27].

All the specimens are free, but with large and clearly defined basal scars. They are truncate in form, the height of the corallum being in all cases less than the length of the calice. The margin of the calice is entire, the ends of the long axis are

from 2 to 10 mm. below the sides, and the latter may be straight, convex, or slightly concave. The corallum is completely covered by an epitheca marked by slight vertical ridges and horizontal concentric lines of growth. There is almost always a root-like process at either end of the basal scar, and often one or two pairs nearer the calice. The septa, which are somewhat exsert round the calicular margin, form generally five cycles of six systems; in some the fifth cycle is incomplete. The primaries, secondaries, and tertiaries are equal in size, with their inner edges slightly thickened and sinuous before they unite by means of thick nodular trabeculae to form the loose parietal columella. Occasionally two or three of the quaternaries are similarly thickened and united with the columella. All the septa are ornamented with radiating ridges bearing small spines.

Localities and the relation between the height of the corallum and the calicular and basal measurements, with the variation in the number of root-like processes of the epitheca, are given in the accompanying table.

*Flabellum rubrum.*

No. of specimens.	Locality.	Height of Corallum in mm.	Calice in mm.	Basal scar in mm.	Number of basal processes.
1	Station XXV. Gregory Group. Bottom: stones and broken shell. Depth: 4-14 fathoms.	27	29 × 12	8 × 4	4
2	Station XXV. Gregory Group. Station XXIV. Cat Island. Bottom: rock, sand, and broken shell. Depth: 8-22 fathoms.	25	35 × 10	11 × 5	2
2	Station XVI. Alligator Rock. Bottom: rock and sand or mud. Depth: 9-18 fathoms. Station XVIII. Paye Island. Bottom: sand, shell, and rock. Depth: 10-21 fathoms.	19	22 × 10	8 × 4	2
3	Station XVIII. Paye Island.	17	22.5 × 7	8 × 4	2 or 4
6	Station XVIII. " "	16	23.5 × 8	8 × 4	2, 4 or 6
4	Station XVIII. " "	15	19.5 × 7.5	8 × 4	2 or 4
5	Station XVIII. " "	14	20 × 8	8 × 3	2
2	Station XVIII. " "	13	17 × 7.5	9 × 3.5	2
3	Station XVIII. " "	12	18 × 7	9 × 4	2
1	Station XVIII. " "	10	12 × 6	10 × 4	—



## Family FUNGIIDÆ (Milne-Edwards &amp; Haime).

## Genus FUNGIA Lamarck.

FUNGIA FUNGITES Linnæus.

Var. AGARICIFORMIS Döderlein [7].

*Fungia agariciformis* Lamarck.*Fungia tenuifolia* Milne-Edwards & Haime [26, 27].*Fungia repanda* Milne-Edwards & Haime [26, 27].*Fungia linnæi* Milne-Edwards & Haime [26, 27].*Madrepora fungites* Forskål.

Döderlein [7] identifies *F. fungites* var. *agariciformis* with *F. agariciformis* and *F. tenuifolia*, and *F. repanda* with *F. linnæi*. Milne-Edwards [27], however, gives *F. repanda* as synonymous with *Madrepora fungites* and *F. agariciformis*, and *F. linnæi* also with *M. fungites*; while *F. tenuifolia* he identifies with *F. agariciformis*. The descriptions given by Milne-Edwards of these species show no marked differences beyond those one would expect in a form which Döderlein has shown to be highly variable, and they should therefore, I think, be absorbed into *F. fungites*.

There are in the collection two adult and three young specimens, the latter having well-developed peduncles and being of irregular shape, flat or sometimes slightly concave above. They measure from  $30 \times 22$  mm. to  $64 \times 63$  mm. The two adult specimens are concave below and arched above to a height of 38 mm. in the centre. They measure  $110 \times 98$  mm. The scar of attachment is just to be distinguished.

*Localities*.—Station XXIX. High-Peaked Island. Bottom: coral-reef. 3 young specimens. Locality of adult specimens is unrecorded.

## Genus DIASERIS Milne-Edwards &amp; Haime.

DIASERIS DISTORTA Michelin. (Plate LXXXV. figs. 2 b, 3 a.)

*Fungia distorta* *Diaseris*-form of Döderlein [7].

Bourne [5] has already criticised Quelch's [33] opinion that this species is really nothing more than abnormal specimens of *Cycloseris* (*Fungia*), and shown that broken and repaired forms of the latter differ very markedly from *Diaseris*. Döderlein, however, says that he finds *Cycloseris*-form specimens of *Diaseris distorta*, and Vaughan [37] describes a specimen of *Cycloseris* from the Philippines which had "several sharply indented lines radiating from the base." "This specimen," he says "looks as if its division in *Diaseris* segments had been initiated, but the process not completed. The segments have remained attached, but indications of the arrested division still persist. There are suggestions in some of the other specimens of lines along which division might take place." He also says that while handling a specimen of *D. pulchella* which was circular, a segment broke out; and therefore he considers *Diaseris* inseparable from *Fungia*.

Nevertheless, I think more evidence is necessary before uniting a form with so peculiar a method of reproduction as *Diaseris* with the genus *Fungia*. Plate LXXXV. figs. 2 *a*, *b*, 3 *a*, *b*, show a photograph of a specimen of *Fungia cyclolites* from the Ceylon collection described by Bourne [5], which has been broken and repaired, and for comparison a specimen of *Diaseris distorta* with two segments.

The collection includes one specimen measuring 30 × 27 mm. and 20 × 18 mm., and a few fragments.

*Locality*.—Station XIII. Maria Island. Bottom: rock and sand. Depth: 8–10 fathoms. One specimen.

Family EUPSAMMIIDÆ Bourne [5].

By RUTH M. HARRISON.

Genus BALANOPHYLLIA Searles Wood.

BALANOPHYLLIA SOCIALIS Semper [34].

*Rhodopsammia socialis* Semper.

Six examples, of which the largest measures exactly 30 mm. in height, calice 10 × 8·5 mm., depth of calice 8 mm.; the smallest is but 10 mm. high, with a nearly circular calice, 6 × 5·5 mm., and 3·5 mm. in depth. The largest specimen shows two lateral scars, one about halfway up the corallum, and the other on the opposite side at a quarter of the entire length from the lip of the calice. Another specimen has two small swellings, the beginnings of lateral buds on opposite sides immediately below the lip of the calice, and below these again on one side is the old scar of a former bud, and on the other is a large lateral bud nearly as large as the parent zooid, and having itself two very fresh lateral scars. The remaining four specimens are obviously young individuals, the two smaller have such very freshly-made basal scars as to suggest that they may have been artificially broken off.

Table of measurements in mm.

	<i>Height.</i>	<i>Calice.</i>	<i>Depth of calice.</i>
1 .....	30	10 × 8·5	8
2 <i>a</i> .....	26	12 × 10	9·5
2 <i>b</i> .....	22	11 × 9	8
3 .....	18	8·5 × 7	5
4 .....	17	8 × 6·5	5
5 .....	16	8 × 7	5
6 .....	10	6 × 5·5	3·5

The table of measurements illustrates the fact pointed out by Semper, that in the young individuals the calice is circular, and the tendency to become oval increases with the age of the individual. The columella is but poorly developed in very young

individuals, becoming more pronounced in older specimens. In all other characters the Burmese specimens agree very exactly with Semper's and Bourne's descriptions of those from the Philippines and Ceylon.

*Locality*.—Station IX. Bentinek Island and Court's Island. Bottom : sand and shell. Depth : 12–26 fathoms.

*BALANOPHYLLIA STOKESIANA* Milne-Edwards & Haime.

*Leptopsammia stokesiana* M.-Edw. & H. [25].

Four individuals undoubtedly belonging to this species. The resemblance in general form and mode of growth is borne out in detail in the characters of the costæ and septa. The columella is rather less developed than in the Philippine species, but projects upwards in the calicular fossa.

*Locality*.—Station XXII. Hastings Harbour. Bottom : rock and sand. Depth : 3–20 fathoms, and shore.

*BALANOPHYLLIA PROFUNDICELLA* Gardiner [14].

Three specimens which, with much hesitation, I refer to this species, as they do not appear to differ sufficiently from the description of the type-specimen to justify the creation of a new species.

Table of measurements in mm.

<i>Height.</i>	<i>Calice.</i>	<i>Depth of calice.</i>
22	9.5 × 8	6
16	11.5 × 9.5	5.5
14	9 × 7.5	4

In all three examples the corallum is straight and cylindrical, attached by a spreading base. Epitheca absent ; costæ correspond to septa, broad, subequal, and are visible from the base upwards. Calice oval, fossa not very deep, with a well-developed columella which projects upwards slightly, and has a rounded, somewhat dome-like appearance. Septa in six systems of four cycles, with traces of an incomplete fifth cycle. Primaries and secondaries somewhat exsert, but in all three specimens the lip of the calice is more or less broken, and the character is not very obvious. The quaternaries fuse over the tertiaries and again over the secondaries deep down in the calice. The granulations on the septa of the primary and secondary cycles are extremely fine in the tallest of the three specimens ; in the two others the granules have run together to form fine radial ridges ; the edges are entire ; the edges of the septa of the lower cycles are denticulate.

In the shallower calicular fossa and the denticulate edges of the septa of the third and lower cycles, these forms resemble *B. parvula* (Moseley [28]), which, as Gardiner has pointed out, comes very near to the present species ; but the quaternaries are

not prominently exsert as in the 'Challenger' specimen; and as in other respects the Burmese specimens resemble Gardiner's specimen from Lifu, it is better to retain them with this species.

*Locality*.—Station XXIV. Cat Island. Bottom: rock and sand and broken shell. Depth: 8–22 fathoms.

BALANOPHYLLIA PARALLELA Semper [34].

*B. parallela* Bourne [5].

There are thirteen examples of this species, varying in height between 9 and 25 mm., and another closely-allied specimen which is notified below.

Table of measurements in mm.

<i>Station.</i>	<i>Height.</i>	<i>Calice.</i>	<i>Depth of calice.</i>
IV. ....	22	16.8 × 12.5	8
IX. ....	25	16 × 12	8
IX. ....	24	17 × 12	8
IX. ....	22	14 × 11	8
IX. ....	19	13 × 9.5	6
IX. ....	19	12 × 9	6
IX. ....	18	11 × 9	5
IX. ....	16	11 × 8.5	5
IX. ....	15	9.5 × 8	5
IX. ....	11	9 × 7.5	4
IX. ....	11	9 × 7	4
IX. ....	9	8 × 7	3
XXV. & XXVI. ...	23	17 × 13	8
XXII. ....	26	15 × 11	6

The costæ are not quite so clearly defined in the upper portion of the corallum, but it is possible to trace one in connection with each septum; in the lower part of the colony they are very distinct and identical with those of the Ceylon specimen. The septal characters are similar in every particular.

*Localities*.—Station IV. King Island. Bottom: rock and sand. Depth 8–25 fathoms. 1 dead specimen.

Station IX. Bentinek Island and Courts Island. Bottom: sand and shell. Depth: 12–26 fathoms. 11 specimens.

Stations XXV. & XXVI. Gregory Group. Bottom: stones and broken shell. Depth: 4–14 fathoms. 1 specimen.

Another specimen resembles *B. parallela* so closely that it seems advisable to place it with that species. The costæ are well defined throughout the entire length of the corallum, in this resembling the Ceylon specimen; but the costæ corresponding to the septa of the first two cycles are slightly larger and more exsert; this is more obvious on one side of the individual than the other. The columella is compressed from side to side, and



projects upwards as a long narrow ridge. Other septal characters are identical with those of *B. parallela*.

*Locality*.—Station XXII. Hastings Harbour. Bottom: rock and sand. Depth: 3–20 fathoms and shore.

*BALANOPHYLLIA IMPERIALIS* Kent [19]. (Plate LXXXVI. figs. 5 a, b, & c.)

Two examples, one attached, the other broken off from its attachment. Corallum straight, conical, one specimen increasing in width much more than the other. Transverse outline of calice elliptical, ends of long axis depressed.

Table of measurements in mm.

<i>Height.</i>	<i>Calice.</i>	<i>Depth of calice.</i>
26	20 × 14	7
23	14 × 10.5	5

An “epitheca” covers the lower half of the broader specimen and three-quarters of the narrower one; both were covered by encrusting Polyzoa and *Serpula* tubes. Costæ exactly corresponding to and continuous with all septa; in some cases the junction of the fifth to the fourth cycle of septa is marked externally by a corresponding junction of the costæ. All costæ slightly, but very distinctly, and equally exsert, the upper edges where they pass into the septa rounded and entire; granulations coarse, having the appearance of longitudinal rows of small spines. Septa in five absolutely complete cycles, all covered irregularly with numerous fine granulations; septa of the first two cycles equal in size, reaching the columella, at which point they are thickened; edges of these septa, also the upper half of the septa of the third cycle, entire; septa of the third cycle also reach the columella, and are thickened at the point of junction, lower edges denticulate; septa of the fourth and fifth cycles grouped in typical Balanophyllid manner round septa of the third cycle; edges denticulate. Calicular fossa large and moderately deep. Columella well developed, trabecular and spongy, with a convex surface.

*Localities*.—Station XVIII. Paye Island. Bottom: sand, shell, and rock. Depth: 10–21 fathoms. The larger specimen.

Station XXII. Hastings Harbour. Bottom: rock and sand. Depth: 3–20 fathoms. The smaller specimen.

I refer this very beautiful coral to the species from Singapore in the National Collection described by Saville Kent [19], in spite of the following differences: the great difference in size, the larger of the specimens in the present collection is only half the size of the one from Singapore; the erect mode of growth; the presence of an epitheca; the rougher, more spinose character of the costæ. However, none of these difficulties need be insuperable.

Size is obviously a character which must vary, and within certain limits cannot be regarded as a distinction between species; shape must necessarily be determined to a great extent by local external conditions, concerning which there is no information; the "epitheca" of the Burmese specimens may possibly have been formed secondarily in self-preservation from the encrusting parasites which surround the lower portion of the corallites, and may not be a true epitheca at all; and the costæ of these smaller and probably younger individuals have not yet become so smooth and worn as those of the larger Singapore specimen.

The absolute symmetry of the internal structures, the characters of the septa, and their entire edges passing into the costæ, sufficiently establish its identity.

*BALANOPHYLLIA DIFFUSA*, sp. n. (Plate LXXXV. figs. 4 *a* & *b*.)

Two examples, both broken from their attachment; slightly curved, with slight circular swellings visible externally at various heights. Transverse outline of calice elliptical, lip of calice not thickened.

<i>Height.</i>	<i>Calice.</i>	<i>Depth of calice.</i>
25	13 × 9	3
20	12·5 × 10	3

Epitheca absent. Costæ visible from the base upwards, but not exsert, rather broad, and beset with low granulations; the junction of the fifth to the fourth cycle of septa is, in some cases, accompanied by a corresponding junction of the costæ externally. Septa in six systems of four cycles, with an incomplete fifth cycle; septa of the first two cycles equal, somewhat exsert, edges smooth and entire, slightly thickened peripherally, and inclined to become fenestrated; granulations tend to run in longitudinal and radial rows; septa of the lower cycles arranged in typical *Balanophyllid* manner, edges very irregular and denticulate. Calicular fossa shallow. Columella very highly developed, of a very delicate spongy trabecular texture, and in some places extending between the septa of the first two cycles up the septa of the third cycle to the junction of the third to the fourth cycles. This encroachment of the columella on the interseptal chambers is a character quite distinct from any previously described species.

*Locality*.—Station XXII. Hastings Harbour. Bottom: rock and sand. Depth: 3–20 fathoms and shore.

Genus *HETEROPSAMMIA* Milne-Edwards & Haime.

*HETEROPSAMMIA MICHELINI* Milne-Edwards & Haime [25].

Numerous specimens, 322 in all, from different stations, varying in size between small individuals 7 mm. in height, with calices 7 × 5 mm., to forms twice the size, 15 mm. high, and calices 13 × 9 mm. The great majority have two calices, or else the

typical figure-of-8 form of two individuals in the process of dividing. The joining of the septa of the fifth cycle over those of the fourth is decidedly marked. At the point where the junction takes place the single septum formed by the union of the two septa of the fifth cycle becomes strongly convex, as Milne-Edwards has already pointed out, and the lower half projects inwards towards the columella beyond the septa of the first three cycles.

*Localities*.—Station VI. Near Grant Island. Bottom: rock and sand or rock and mud. Depth: 3–7 fathoms. 14 specimens.

Station XXX. Fly Island. Bottom: rock and sand. Depth: 8–15 fathoms. 307 specimens.

Station XXXIII. Christmas Island. Bottom: rock, sand, and mud. Depth: 8–23 fathoms. 1 specimen.

#### Genus DENDROPHYLLIA Milne-Edwards & Haime.

In the present collection there are three species of Colonial Madreporaria which have points in common with Milne-Edwards and Haime's original three genera *Dendrophyllia*, *Cænopsammia*, and *Lobopsammia*, and the difficulty of deciding to which they belong is such that it will probably be convenient in the future to recognize but one genus instead of three. In the original diagnosis of the genus *Cænopsammia* by Milne-Edwards and Haime, the close connection between the three genera was pointed out; but *Dendrophyllia* and *Lobopsammia* are distinguished from the former by the star-like appearance of their calices (l'aspect étoilé des calices). Klunzinger has remarked on the same difference; speaking of *Cænopsammia* he says:—"Daher ist hier auch das für die Familie charakteristische Zusammenlaufen der kleineren Septa hier nicht oder wenig ausgesprochen (zum Unterschied von *Dendrophyllia*)."

*Cænopsammia* has only three complete cycles of septa; *Dendrophyllia* and *Lobopsammia* have four complete cycles. *Lobopsammia* propagates by fissiparity; both *Dendrophyllia* and *Cænopsammia* propagate by gemmation. Verrill has already placed *Cænopsammia* with *Dendrophyllia*, and in this has been followed by most subsequent authors, and the specimens in this collection not only justify this conclusion, but make it seem advisable to include *Lobopsammia* in one and the same genus with *Cænopsammia* and *Dendrophyllia*. The species I identify as *Dendrophyllia coccinea* (*Cænopsammia coccinea* M.-Edw. & H.) in general appearance and mode of growth is very like *C. tenuilamellosa* and *C. ehrenbergiana* (M.-Edw. & H. [25. pl. i. figs. 11 & 12]), and Wayland Vaughan's figure (37. pl. xlv. figs. 6 & 6 a) of Verrill's original specimen of *Dendrophyllia manni* (*Cænopsammia manni* Verrill). The septal arrangement is very dendrophyllid in character, the star-like appearance caused by the union of the fourth to the third cycle of septa about halfway between the lip of the calice and the columella being pronounced. The septa are so irregular as regards both cycles and systems that they afford no certain guide. In the smaller colony of the East African species there is one individual with a complete fourth cycle (*Dendrophyllia* and *Lobo-*

*psammia*) fig. 7 *a*; another individual with an incomplete fourth cycle (*Cænopsammia*) fig. 7 *b*; while a third individual which has lately become separated off has not even the typical six systems of cycles, fig. 7 *c*, but four complete cycles of four systems. In the larger colony is an individual which clearly proves that new zooids are formed by fission and not by gemmation (*Lobopsammia*), fig. 7 *d*; for here the lip of the calice has been drawn out into an oval, a strong ridge has grown across the centre, and the two individuals are incompletely separated; the septal systems are incomplete in both, but four systems can be distinguished in one and two in the other. A comparison of this figure (fig. 7 *d*) with fig. 7 *c* throws a light on the interpretation of the septal arrangement of the latter; the ridge that has grown across the double calice divides it into two unequal parts. The larger part contains four nearly complete systems of four cycles, and it is here possible to trace rudiments of the two remaining systems, which will ultimately complete the typical zoantharian six systems; but in the other part, where only two systems of four cycles are discernible, it is possible that the six systems will never be complete, and that this has actually occurred in the individual represented in fig. 7 *c*. The process of fission has not gone far enough in the double-caliced individual to decide that each zooid will ultimately have its full complement of septal systems, and it has gone too far to be certain that the dividing-ridge has grown, not across the middle but rather across one end of the calice; nevertheless, considering the arrangement of the septa of the zooid represented in fig. 7 *c*, it seems probable that this has been the case, and that this represents four cycles of four systems rather than three cycles of eight; for it is easier to believe that an individual which has been formed by a process comparable to simple binary fission will have a shortage rather than an excess of the normal complement of characters.

From the above discussion it is clear that this species from the Mergui Archipelago breaks down Milne-Edwards and Haime's original generic characters for the three genera *Dendrophyllia*, *Cænopsammia*, and *Lobopsammia*; and the same is true of *Dendrophyllia robusta* (*Lobopsammia robusta* Bourne). Of the three colonies in the Burmese collection, one does not differ in any particular from the original Ceylon specimen, but in both the others it is quite obvious that new individuals are not formed by fission. One of these colonies is represented in fig. 6, but whether the youngest zooid has been formed by gemmation or by the process described and figured by von Koch (20. pl. iii. fig. 21) as "Theilkospung," it is not possible to decide from the material available; but the fact that it has not been a process of fission breaks down an important generic character that separated *Lobopsammia* from *Dendrophyllia* and *Cænopsammia*.

The remaining colonial form appears to be *Dendrophyllia gracilis* (M. Edw. & H.) and offers no special feature that bears on the present argument.



DENDROPHYLLIA COCCINEA M.-Edw. & Haime. (Plate LXXXVI. figs. 7 a, b, c, d.)

*Cænopsammia coccinea* M.-Edw. & Haime.

Two small colonies, one consisting of but four individuals, the other of eleven. Colonies 10 to 20 mm. high respectively, individual corallites rising from 2 to 6 mm. from the general corallum. Costæ well-marked on individual corallites, but lose definition on the general corallum, coarsely covered with granulations. Lip of calice nearly circular, not thickened. The columella is small and is joined by the septa of the first two cycles. Septa in four cycles of six systems, but the systems are very irregular and have already been detailed in the discussion on the genus. Septa of the first two cycles beset with longitudinal rows of conspicuous granules and having irregular somewhat denticulate inner edges; those of the third and fourth cycles are porous and highly denticulated at their inner edges.

*Locality*.—Station XXIV. Cat and Kitten. Bottom: rock, sand, and broken shell. Depth: 8–22 fathoms.

It is not without much hesitation that I identify this species as *Dendrophyllia coccinea* (*Cænopsammia coccinea* M.-Edw. & Haime). The last-named authors have noted the similarity between *C. coccinea*, *C. ehrenbergiana*, and *C. gaimardi*, also between *C. urvillii* and *C. tenuilamellosa*. Klunzinger [21] does not distinguish between *C. coccinea* and *C. ehrenbergiana*: the species in question from Burma, bearing as it does points of similarity with both these and also with *C. tenuilamellosa*, suggests that all the above-mentioned five species are varieties of one variable species.

In general appearance, septal arrangement, and the irregularity of the orders of septa the Burmese species resembles *C. tenuilamellosa*, but differs from it in having a very much reduced columella and septa covered with coarse granules; in these characters it resembles *C. coccinea*, but the granules of the septa of the latter are described as very small, which can hardly be said of the species under discussion. Klunzinger has remarked great variability in the development of the columella in individuals of the same colony, and therefore discounts it as a distinguishing specific character.

The Burmese species is intermediate between *C. coccinea*, *C. ehrenbergiana*, and *C. tenuilamellosa*; I therefore give it the generic and specific names that have priority—*Dendrophyllia coccinea*.

DENDROPHYLLIA ROBUSTA Bourne. (Plate LXXXVI. fig. 6.)

*Lobopsammia robusta* Bourne.

Three colonies, all considerably smaller than the original specimen described by Bourne, but, as has been already suggested in a previous part of this paper, size cannot be regarded as a character of any specific importance. The largest calice of the Burmese specimens measures 12 × 8 mm., the smallest 5.3 × 5 mm.; and

the columella in no individual is as pronounced as that of the Ceylon specimen [5. pl. ii. fig. 10 *a*]; but as it is so much reduced as to be practically non-existent in the youngest individual, and considerably more developed in older individuals, the fact that it never reaches the dimensions of that in Bourne's figure may be due to immaturity.

*Localities*.—One colony from Station XVIII. Paye Island. Bottom : sand, shell, and rock. Depth : 10–21 fathoms.

Two colonies from Station XXIV. Cat Island. Bottom : rock, sand, and broken shell. Depth : 8–22 fathoms.

#### DENDROPHYLLIA GRACILIS Milne-Edwards & Haime.

A single individual 12 mm. high, and two young colonies 17 and 19 mm. high, consisting of three and four individuals respectively. The calices of the younger individuals are practically spherical; the columella rises very slightly in the calicular fossa, and in the solitary specimen it is compressed and narrow from side to side. The septa of the first two cycles are not denticulate, but in all other respects it is identical with M.-Edwards and Haime's description.

*Locality*.—Station XXIV. Cat and Kitten. Bottom : rock, sand, and broken shell. Depth : 8–22 fathoms.

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5. Marine Fauna from the Kerimba Archipelago, Portuguese East Africa, collected by Jas. J. Simpson, M.A., B.Sc., and R. N. Rudmose-Brown, B.Sc., University of Aberdeen: MADREPORARIA. By RUTH M. HARRISON and MARGARET POOLE\*.

[Received October 19, 1909.]

This Collection was made between September 1907 and May 1908, and contains two species of Turbinolidæ, four species of Fungiidæ, four species of Astræidæ and one species of Eupsammiidæ.

We are indebted to Dr. Bourne for much help and advice during the progress of the work.

Family TURBINOLIDÆ Milne-Edwards & Haime.

By MARGARET POOLE.

Genus HETEROCYATHUS Milne-Edwards & Haime.

HETEROCYATHUS ÆQUICOSTATUS Milne-Edwards & Haime [19].

This species has been fully described by me in the account of the Turbinolidæ from the Mergui Archipelago, Lower Burma. It contains three well-defined types differing from each other in the number and characters of the septa and pali, the general shape of the corallum, the depth and size of the calicular fossa and the position of the lateral pores. All three varieties are, however, connected by beautifully intermediate forms, as is shown in a photograph in the paper referred to above.

The collection contains ten specimens, of which four belong to type II. and six to type III.; the first type being unrepresented.

*Localities.*—Station I. Tunghi Bay. Bottom: sand, mud, and shell. Depth: 5–18 fathoms. 2 specimens of type II. and 4 of type III.—Station VI. Kero-Nyuni Bay. Bottom: sand. Depth: 5–10 fathoms. 2 specimens of type II. and 2 of type III.

Genus PARACYATHUS Milne-Edwards & Haime.

PARACYATHUS CAVATUS Alcock [1].

There is a single small and very irregular colony of five calices, which with much hesitation I identify as the above species. The whole measures  $24 \times 18$  mm. and 14 mm. in height from the broad encrusting base. The largest calice measures  $11 \times 9$  mm. and 2 mm. in depth.

This is a new species established by Alcock, which he says is very near the fossil form *Paracyathus crassus* of Milne-Edwards and Haime.

*Locality.*—Station II. Maiyapa Bay. Bottom: sand, mud, and coral. Depth: 10 fathoms.

\* Communicated by Prof. G. C. BOURNE, D.Sc., F.Z.S.

## Family FUNGIIDÆ (Milne-Edwards &amp; Haime).

## Genus FUNGIA Lamarck.

## FUNGIA PATELLA Milne-Edwards [21, 22].

This is the *F. patella* *Cycloseris*-form of Döderlein [7, pl. i.], and is identical with the figures given by Gardiner of *Cycloseris hexagonalis* [14, pl. xx.], which species the latter writer in his recently published report of the Percy Sladen Trust Expedition to the Indian Ocean [18] has absorbed into *F. patella*. The East African specimens entirely justify his abolition of the species *Cycloseris hexagonalis*.

There are eight specimens measuring from  $26 \times 25$  mm. to  $56 \times 55$  mm. The younger specimens show a well-defined scar of attachment.

6 specimens are from Station VI. Kero-Nyuni. Bottom: sand. Depth: 5-10 fathoms. And 2 from Station XIII. Pemba Bay. Bottom: muddy. Depth: 10-20 fathoms.

## FUNGIA CYCLOLITES Lamarck.

*Cycloseris cyclolites* of Milne-Edwards [22] and Gardiner [13] has recently been abolished by the latter, and Wayland Vaughan [30], the characters by which it was originally distinguished from the genus *Fungia* having proved to be of nothing more than specific value.

There is one specimen from Station VI. Kero-Nyuni. Bottom: sand. Depth: 5-10 fathoms. Measuring  $62 \times 53$  mm.

The scar of attachment is entirely obliterated.

## FUNGIA FUNGITES Linn., var. AGARICIFORMIS Döderlein [7].

There are four young specimens of irregular shape and with well-marked scars of attachment.

*Locality*.—Station II. Maiyapa Bay. Bottom: sand, mud, and coral. Depth: 10 fathoms.

## Genus DIASERIS Milne-Edwards &amp; Haime.

## DIASERIS DISTORTA Michelin.

Two complete specimens and some fragments.

In the account of the corals from the Mergui Archipelago mentioned above, I have shown that more evidence is necessary before the genus *Diaseris* can be absorbed by the genus *Fungia*, and have had photographed for comparison a specimen of *D. distorta* with two segments, and one of *Fungia cyclolites* which has been broken and repaired, to show the difference in the arrangement of the septa.

*Locality*.—Station I. Tunghi Bay. Bottom: sand, mud, and shell. Depth: 5-18 fathoms.

## Family ASTRÆIDÆ Dana.

## Genus TRACHYPHYLLIA Milne-Edwards &amp; Haime.

## TRACHYPHYLLIA AMARANTUM Milne-Edwards &amp; Haime [22].

There are twelve young solitary specimens having calices from  $17 \times 13$  to  $46 \times 26$  mm., coralla from 10 to 38 mm. in height.

There are also seven older specimens undergoing fissiparity into two or four parts. These have calices of  $80 \times 48$  mm., and the coralla are 58 mm. in height.

*Localities*.—Station I. Tunghi Bay. Bottom: sand, mud, and shell. Depth: 5–18 fathoms. 1 adult specimen.—Station III. Mtundo Bay. Bottom: sand, shell, and coral. Depth: 6 fathoms. 5 young specimens.—Station VI. Kero-Nyuni. Bottom: sand. Depth: 5–10 fathoms. 4 young specimens.—Station XI. Manangoroshi Point. Reefs. 2 young specimens.—Station XIII. Pemba Bay. Bottom: muddy. Depth: 10–20 fathoms. 1 very young specimen. Locality of the remaining 6 dead adult specimens is unrecorded.

## Genus MUSSA Oken, Milne-Edwards &amp; Haime.

## MUSSA CRISTATA Milne-Edwards [22].

The collection contains only a small dead colony, consisting of one isolated and five united calices. The whole colony measures about  $120 \times 90$  mm. and rises to a height of 80 mm. The separated calice measures  $45 \times 35$  mm.

This species apparently differs from *M. distans* of Klunzinger [17] only in possessing an incomplete fifth cycle of septa, a character which seems insufficient for the establishment of a new species.

*Locality* unrecorded.

## Genus FAVIA Oken, Milne-Edwards &amp; Haime.

## FAVIA OKENI Milne-Edwards &amp; Haime [22].

*Parastrea radiata* Milne-Edwards & Haime.

The collection contains a single almost circular colony of nine distinct calices, measuring 25 mm. in diameter and rising to a height of 17 mm. Klunzinger (17, t. iii. fig. 4) gives a photograph of this species under the name of *F. cavernosa* Forskål.

*Locality* unrecorded.

## Genus GYROSMILIA Milne-Edwards &amp; Haime.

## GYROSMILIA INTERRUPTA Milne-Edwards &amp; Haime [22].

There is a circular and smoothly convex colony of this species, measuring 90 mm. in diameter, and reaching a height of 60 mm. at the centre of the colony. The under surface is covered by a

thin radially-striated epitheca, and is attached to the substratum in the middle by an irregular, short peduncle. Klunzinger also gives an excellent photograph of this species (17, t. i. fig. 8).

*Locality* unrecorded.

### Family EUPSAMMIIDÆ Bourne [5].

By RUTH M. HARRISON.

#### Genus HETEROPSAMMIA Milne-Edwards & Haime.

#### HETEROPSAMMIA MICHELINI Milne-Edwards & Haime [20].

There are three specimens, of which one has two incompletely separated calices, and both the others each two distinct individuals.

*Localities*.—Station III. Mtundo Bay. Bottom: sand, shell, and coral. Depth: 6 fathoms. 2 specimens.—Station VI. Kero-Nyuni. Bottom: sand. Depth: 5–10 fathoms. 1 specimen.

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6. Some Notes upon *Boa occidentalis* and *Boa (Pelophilus) madagascariensis*. By FRANK E. BEDDARD, M.A., F.R.S., F.Z.S., Prosector to the Society.

[Received October 26, 1909.]

(Text-figures 281-285.)

In a series of papers recently communicated to this Society, to which I shall refer in the course of the present communication, I have dealt with a number of points in the anatomy of certain snakes of the family Boidæ belonging to the following species:—*Eunectes murinus*, *E. notæus*, *Boa constrictor*, *B. diviniloqua*, *Eryx conicus*, *E. jaculus*, *E. johni*, *Corallus cookii*, *C. madagascariensis*, *C. caninus*, *Python spilotes*, *P. sebæ*, *P. molurus*, *P. regius*, *Enygrus carinatus*.

I have, recently had the opportunity of examining a specimen apiece of the two species of *Boa*, *B. occidentalis* and *B. madagascariensis*. The latter species has been referred to a genus *Pelophilus*, and it is one of the species of *Boa* which occurs in Madagascar. The distribution of this genus *Boa* is exactly paralleled by the distribution of the allied genus *Corallus*. For in both the majority of the species are Neotropical in range, while one or two are confined to the island of Madagascar. It is therefore of particular interest to be able to compare the characteristics of the Madagascar *Boa* with those of its Neotropical allies, and to set side by side the facts thus obtained with those resulting from the anatomical study of the Madagascar and Neotropical species of *Corallus*. To some extent I am able, in the present communication, to accomplish this comparison; but various reasons prevented me from being able to give so complete an account of the facts as might be desired in the two species. I can, however, direct attention to the more important among these. I shall deal with them in a comparative fashion, describing the conditions of the lungs and certain blood-vessels in the two species.

§ *Lungs.*

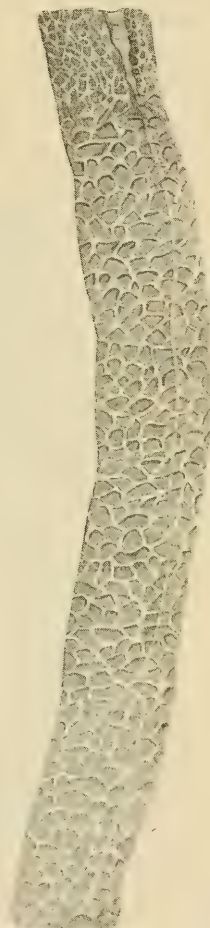
In *Boa occidentalis* the conditions of the two lungs differed somewhat, as is the rule among these serpents. Not only are the two lungs unequal in size, as is universal (?) among those Boidæ (the vast majority) which possess two lungs, but the windpipe divides into two bronchi, which are unlike in the case of the right and the left lung. In this species the bronchus of the smaller lung projects but a short way into its interior as a flattened plate; its length was at most half an inch. At its extremity the bronchus did not tail off into a seam running along the lung substance such as occurs, as will be mentioned presently, in the other lung. Its condition can be contrasted

with that of the larger lung, which is represented in the drawing exhibited herewith (text-fig. 281). The bronchial gutter of the

Text-fig. 281.



Text-fig. 282.



Text-fig. 281.—Interior of anterior half of larger lung of *Boa occidentalis*, showing bronchial gutter within lung.

A. Orifice of bronchus of other lung.

Text-fig. 282.—A portion of the larger lung of *Boa occidentalis* immediately following that illustrated in text-fig. 281. The end of the bronchial gutter is shown and the "seam" continuous with it, which bifurcates distally.

larger lung extends along that lung for fully seven inches, the disproportion between the two lungs in this respect being therefore

enormous and bearing no possible relation to their relative size, for the larger lung is at most twice the size of the smaller. At its extremity the bronchial gutter narrows to almost thread-like proportions. There was no trace that I could discover of a condition like that of *Corallus caninus*\*, where the semirings become irregular in position and leave tracts of lung substance between them. The bronchus was perfectly continuous as such up to its very end. It is furthermore to be noted that the gutter-like character of the imperfect bronchus is very marked here. I should imagine, indeed, that it may become functionally a tube within the lung under certain conditions. Under such circumstances the rapid distention of the terminal anangious region of the lung might be effected, for terrifying or other purposes. As in some other snakes, of which particular mention will be made presently, *Boa occidentalis* shows a seam running a considerable distance along the lung which starts from the termination of the bronchus in the larger lung. As is to be seen from an inspection of the accompanying figure (text-fig. 283), this seam appears to be quite independent of the partitions between the alveoli of the lung. It is evidently a structure distinct from them, for in some cases it crosses a definite alveolus at the middle. The seam is, in fact, not merely the coalescence of the walls of a series of alveoli. This fact (*i. e.* that it is an independent structure) seems to show that the view generally held as to the nature of this seam, namely that it is a rudiment of the bronchus, is the correct view. The seam extends far into the anangious region of the lung, and, as already mentioned, it is only in this larger lung that it occurs, being absent in the smaller.

This seam extends for a distance down the lung which is fully as great as the length of the bronchial gutter. Its diameter is about as great as that of the stouter alveolar walls. But this fact does not permit of any confusion between the structures, nor hinders the accurate tracing of the course of the bronchial seam. For the latter is of a distinctly white colour as compared with the brown colour of the inner surface of the lungs including the walls of the alveoli—due to the formalin in which the lung was preserved. Another reason which leads to the easy identification of this fibrous seam throughout its whole course has already been briefly mentioned. The seam appears to cross over the lung alveoli, and is thus evidently not composed of a series of coincident alveolar walls. But more than this can be observed in its relations to the alveolar walls. It will be seen from an inspection of the accompanying figure (text-fig. 283) that the seam does not fuse with the alveolar walls but passes above them, and is indeed quite independent of them. All this of course establishes on a very firm basis the view that this seam is a real continuation of the bronchus as it appears to be. It has already been mentioned that in the smaller lung there is no trace

\* "A Comparison of the Neotropical Species of *Corallus*, &c.," P. Z. S. 1908, p. 135; see text-fig. 27, p. 156.



of any such seam; the bronchus in this lung ends abruptly, and there is no diminution towards or at the end in the calibre of its semirings. On the other hand, in the larger lung the cartilages, though continuing to the end of the intrapulmonary bronchus, get successively narrower and narrower. I have not observed in other Boas and Pythons where a fibrous continuation of the intrapulmonary bronchus occurs, any suggestion of a branching of this seam, which I now proceed to describe in *Boa occidentalis*.

Text-fig. 283.



A magnified representation of the end of the bronchial gutter in the same lung as shown in text-figs. 281 & 282, to show the double origin of the seam and its independence from the walls of the pulmonary alveoli.

At a considerable distance behind the termination of the intrapulmonary bronchus the seam gives off a branch (see text-fig. 282, p. 919) which runs obliquely towards that wall of the lung which is contiguous with the wall of the smaller lung. This seam is no smaller than the main seam, of which it is a branch, and shows the same characters that have been enumerated above. It ends by bifurcating into two branches.

This fact appears to me to be of the most interesting

significance. If it be admitted that the fibrous seam connected with the bronchus is the degenerate equivalent of a further extension into the lung of the bronchus, it follows that the branching of this seam is a trace of a former branching within the lung of the bronchus. In fact, that we have in the snake's lung evidence of a reduction to its present simplicity from a lung more like that of a Tortoise or Crocodile, or—and this comparison may be better—a *Varanus*. For in these latter types the intrapulmonary region of the bronchus is branched or shows traces of branching. In this case the simple character of the lung of the Boidæ is not to be strictly compared with the simple sac-like lung of, e. g., *Hatteria*. For the latter exhibits, as I believe, a primitive state of affairs, and is not much more evolved than the lung of an Amphibian, while the former may have returned to the simple condition through degradation.

We may now contrast the structure of the lung in *Boa occidentalis* with that of *B. madagascariensis*. In the latter species each bronchus enters its lung, and there is thus, as in *B. occidentalis*, an intrapulmonary bronchus. But the intrapulmonary bronchus is very short in the case of both lungs, though the larger lung has a rather longer intrapulmonary bronchus. I found that the measurements were seven eighths of an inch in the case of the larger lung and three eighths in the case of the smaller lung; thus the intrapulmonary bronchus was in the larger lung about double the length of that of the smaller lung. It is clear, therefore, that there is here a very great difference both actually and proportionately (as concerns the two lungs), between the Madagascar species and the Neotropical species which are considered in the present communication. Furthermore, there is not a marked seam continuing down the bronchus in the case of either lung. There appears to be one; but when the lung tissue is stretched the seam disappears. This is analogous to what I have described in *Corallus*. We have therefore a second important difference in the structure of the lungs between *Boa occidentalis* and its Madagascar ally.

I have already described or confirmed the description of the intrapulmonary bronchi of the two American species\* *Boa constrictor* and *B. diviniiloqua*. In both of these the bronchus extends a long way down into the interior of the larger lung exactly as I have just shown to be the case in *B. occidentalis*. With regard to the extension of the bronchus into the smaller lung, it would appear that *Boa occidentalis* occupies a position exactly intermediate between the two other species. For in *B. diviniiloqua* the bronchus extends for a goodish way into this lung, while in *Boa constrictor* there is no intrapulmonary bronchus at all within the smaller lung. In any case there is a general agreement between the three Neotropical species of *Boa* dealt with in the present communication, and a difference

\* P. Z. S. 1906, p. 516.

between all of them and the Madagascar species. It is interesting to note that while the corresponding species of *Corallus* also differ in the structure of the lungs, the difference is of precisely the reverse kind to that which we find in *Boa*. For in *Corallus* it is the Madagascar species\* which possesses the long intrapulmonary bronchus and the Neotropical forms which have a short intrapulmonary bronchus.

### § *Aorta and Intercostal Arteries.*

The great variations which the system of intercostal arteries shows among Serpents as contrasted with the Lacertilia is a remarkable fact in the anatomy of the former order of Reptiles, and is one of the many anatomical facts which prove their comparative remoteness in affinity from the Lizards. Moreover, the condition of these arteries appears to be quite constant for a species, and even for groups of species, though the current generic divisions among the Boidæ are not in entire harmony with the arrangement of the intercostal arteries. In a series of papers† dealing with these and other points in the anatomy of the Boidæ, I have got together a considerable number of facts relative to the distribution of the intercostal arteries in those serpents.

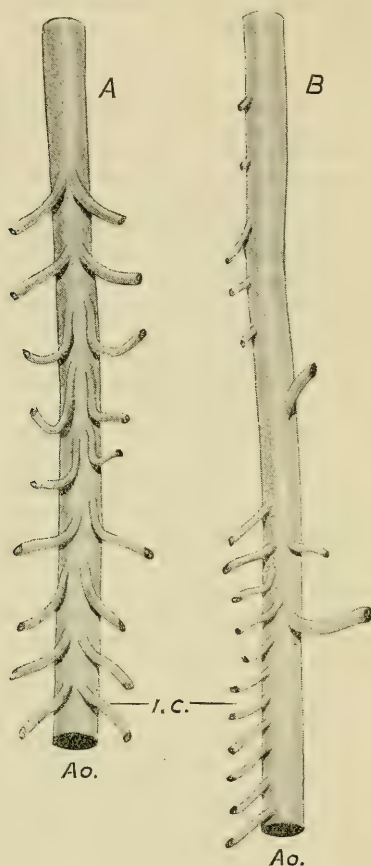
I have in the present paper some new facts to add to those already collected, which I shall describe before considering the classificatory results which appear to follow from a comparison of the actual facts with those already known. In *Boa occidentalis* the aorta in the region of the liver is by no means nearly in contact with the dorsal parietes. It lies at some distance within the body from the dorsal middle line of the body. It is possible that this fact of position has something to do with the differing arrangement of the intercostal arteries shown in this region of the body as compared with the posterior region of the body of the serpent. In any case, in the hepatic region the intercostal arteries arise singly and at considerable intervals from the ventral surface of the aorta. There are altogether very few of them. They become connected at a short distance from the dorsal middle line with smaller trunks running fore and aft in close relation to the middle line of the body. From these secondary longitudinal arteries arise in regular pairs the actual intercostal twigs. In the abdominal region of the body, as it may be termed, near to the kidneys, the intercostal arteries are different in their arrangement.

\* P. Z. S. 1908, p. 151.

† "Contributions to our Knowledge of the Circulatory System of the Ophidia," P. Z. S. 1904, vol. i. p. 331. "Notes upon the Anatomy of certain Snakes of the Family Boidæ," P. Z. S. 1904, vol. ii. p. 107. "Contributions to the Knowledge of the Vascular and Respiratory Systems in the Ophidia and to the Anatomy of the Genera *Boa* and *Corallus*," P. Z. S. 1906, p. 499. "A Comparison of the Neotropical Species of *Corallus*, *C. cookii*, with *C. madagascariensis*, and on some points in the Anatomy of *Corallus caninus*," P. Z. S. 1908, p. 135.

Here there is no development of a series of secondary longitudinal trunks. The aorta itself is in close apposition to the dorsal middle line. And the intercostal branches arise in regular pairs,

Text-fig. 284.



Two isolated pieces of the dorsal aorta of *Boa madagascariensis*.

A. From the region of the kidney. B. From the region of the liver.

Ao. Aorta. i.e. Intercostal arteries.

The arteries shown to the right of B are hepatic or gastric arteries.

one pair to each vertebra, from the aorta itself. The development of secondary longitudinal trunks, which is so common a phenomenon in veins and arteries among the Ophidia, is, however, seen



in this region of the body, though not in any way comparable to the secondary longitudinal trunks already described in the more anterior region of the body. Laterally, and here and there, there are slender longitudinal arteries connecting a successive series of intercostals at some distance from their origin from the aorta. This, it will be seen, is quite a different thing to the conditions described in the more anterior region of the body where the longitudinal trunks occur before the intercostals are given off. This, then, is the state of affairs which the intercostal arteries of *Boa occidentalis* show. In the Madagascar species the intercostals are different in their origin anteriorly. In the liver region of the body the intercostals arise regularly from the aorta itself, and vary as to whether they arise actually in pairs or from a single branch which shortly divides in a Y-like fashion to form the intercostal of each side. This is shown in the accompanying figure (text-fig. 284), which represents a piece of the aorta in the anterior region of the body. In the kidney region the intercostals are also given off in regular pairs from the aorta itself, and are paired from the very first. Thus *Boa madagascariensis* agrees with *B. occidentalis* in the origin of the more posteriorly situated set of intercostals, but differs in the origin of the more anteriorly situated set. We find, therefore, that in the intercostal arteries, as in the structure of the lungs, the Madagascar species of *Boa* differs from the Neotropical *Boa occidentalis*. It is furthermore important to note that the Neotropical species of *Boa* described in the present paper agrees in the points just raised with the other two Neotropical species, viz., *B. divinitoqua* and *B. constrictor*. A difference in geographical position thus corresponds with certain definite structural differences. Finally, it is not without interest to observe that there is a very close parallel between the New World and Old World Boas on the one hand, and the New World and Old World *Corallus* on the other hand.

The parallel, moreover, is more exact than that which can be drawn in the case of the lung. For the difference in the intercostal vessels between the Boas of the Neotropical region and that of Madagascar is quite the same as that between the two Neotropical species of *Corallus* which have been studied and their Madagascar representative. I have already described the latter facts in some detail\*, and refer to my description. Had the parallel in the structure of the lungs been as close as that which the arterial system shows, it might have been permissible to consider the question whether the Madagascar Boines of both genera were not better included in the same genus. At present, however, this alteration of existing views seems to me to be premature.

\* "A Comparison of the Neotropical Species of *Corallus*, &c.," P. Z. S. 1908, p. 135.

### § Renal Arteries.

In the series of papers dealing with the anatomy of the Boidæ, to which I have referred in the course of the present communication, I have many times mentioned the fact that among the Boidæ the existence of but a single artery to each kidney is the rule, with but slight exceptions.

It may now be safely asserted that this diminution in the number of the renal arteries, which never exceed two to each kidney, and that only in the genus *Eryx*, is a characteristic of the group. *Boa occidentalis* is no exception to this rule, and I found in the case of one kidney but one renal artery, which was followed carefully from its origin from the aorta down to the end of the kidney, which it first touches at the anterior end of that viscus. In the case of the other kidney, it seemed to me (and though I am not quite positive as to the fact, I am very nearly sure) that the single renal artery arose not independently from the aorta, but as a branch of one of the intestinal arteries. Unfortunately, the condition of the renal arteries is one of the points which I did not ascertain in the species *Boa madagascariensis*.

### § Alimentary Viscera.

There is frequently an inequality between the two lobes of the liver in Serpents, and among them in the Boidæ. Up to the present, I believe that the most marked case of inequality in length between these two lobes occurs in *Corallus madagascariensis*, where I have described it.

In that snake\* the long thin "tail" of the liver was some four inches long. I have now to record the same kind of inequality in *Boa occidentalis*, where, however, it is not so marked as in the species of *Corallus*, but still very striking. In the example of *Boa occidentalis* which I dissected, the "tail" measured about 3 inches, as is shown in the accompanying figure (text-fig. 285). The *stomach* of the same snake, which was in a contracted condition, showed on each side a very marked *tænia*.

It is well known that the *small intestine* of snakes is the only region of the gut which is folded, the rest of the alimentary canal being straight. As a contribution to our knowledge of the extent to which this folding takes place, I made some measurements of the small intestine of *Boa madagascariensis*. In this snake the coiled small intestine lay between the pancreas and the region of the testis. It measured no less than 31 inches. The length of the body of the reptile between the points which lodged this coiled gut was only 4 or 5 inches. I did not make a corresponding observation upon *Boa occidentalis*.

\* "Contributions to the Knowledge of the Vascular and Respiratory Systems in the Ophidia, &c.," P. Z. S. 1906, p. 517.

There is some variation among the Boine Snakes in the arrangement of the pancreas and spleen\*. It is, therefore, desirable to record the conditions that I have found in *Boa occidentalis*. I find in that snake that the large rounded pancreas which lies in connection with the duodenal wall is connected with the spleen by an isthmus of pancreatic tissue not of very great

Text-fig. 285.

End of liver of *Boa occidentalis*.

c. Celomic sac of liver partly removed. p.c. Postcardinal vein.

length, but slender and widening out at its contact with the spleen. The latter organ is lobate, and in consequence somewhat mulberry-like in contour. I have no observations concerning these various glands in *Boa madagascariensis*.

\* For a summary of the facts see my paper upon *Corallus* already quoted in P. Z. S. 1908, p. 147.

7. Notes upon the Anatomy of Monkeys of the Genus *Pithecia*. By FRANK E. BEDDARD, M.A., F.R.S., F.Z.S., Prosector to the Society.

[Received October 26, 1909.]

(Text-figures 286-294.)

(1) *Pithecia pithecia*.

A young male example of this monkey lived only for a short time in the menagerie and came into my hands on September 3. Inasmuch as our knowledge of the viscera of this genus is not extensive, I took a number of notes upon certain organs which were best studied in the fresh condition, and preserved for future reference the remaining viscera. The present communication to the Society is the result of the examination of these viscera, from which I am able to compile some account of the principal organs of the body.

So far as I am aware, there is but one paper dealing with the general anatomy of the genus *Pithecia*, and that is by the late Sir W. H. Flower (5). There are, however, notes upon other species scattered through various publications dealing with the New World Primates of which the accompanying bibliography (see p. 943) includes those that I have consulted, as well as others dealing with allied forms of Platyrrhines.

§ *Brain*.

The brain was carefully extracted (after noting the arrangement of the sulci in the fresh brain) and preserved in alcohol. The total length of the hemispheres is 48 mm.; the greatest breadth of the cerebrum is 38 mm. The cerebellum is completely hidden when the brain is viewed from above.

In its general features the brain of *Pithecia pithecia* very closely resembles, as might be expected, that of *Pithecia monachus*, figured by the late Sir W. H. Flower (5, p. 329, figs. 1, 2, 3), one of which figures (fig. 1) is practically identical with Dr. Elliot Smith's representation (11, p. 415, fig. 61) of *Pithecia*, where the brain is drawn from the dorsal aspect. Dr. Elliot Smith does not mention the species referred to, at any rate in the legend beneath the figure. It might, in my opinion, have been copied either from Flower's figure or from the actual brain from which that figure was drawn. Another brain of this species is figured from the lateral aspect by Dr. Elliot Smith in the "Catalogue of the Royal College of Surgeons" (12, p. 392, fig. 230), in which work there is also some description of the brains of *P. satanas* and *P. albinasa*. Concerning the first of these two species, Mr. Forbes has made some observations (3 a). All of these three species of *Pithecia* have been dealt with by Drs. Kükenthal and Ziehen,



whose observations (9) refer, as it would appear, to the actual specimens upon which the facts described in the other memoirs are based. These authors figure a lateral view of the brain of *P. albinasa* and a mesial section of the brain of *P. monachus*. As to previous observations upon the brain of the genus *Pithecia*, they only mention Flower (5) and Turner (13).

In the brain of *Pithecia pithecia* the *sulcus rectus* was evidently of much the same proportionate size, but each sulcus was a simple obliquely running furrow. There was no branch upon the left-hand furrow (or upon the right), such as is represented in all those figures of the brain of *P. monachus* to which I have referred above. It is interesting to note that in *P. satanas* (according to Elliot Smith) it is also the left hemisphere which has a triradiate *sulcus rectus*.

The *sulcus centralis* seems to be exactly as in *Pithecia monachus*. Its inner end (some way distant from the mesial edge of the hemisphere) is 23 mm. from the anterior end of the hemisphere and 25 mm. distant from the hinder end of the hemisphere. It is thus situated very near to the middle point of the brain. These proportions appear to agree very closely with those indicated in Dr. Elliot Smith's figure of the brain of *Pithecia monachus* (11, p. 415, fig. 61).

There are indications of a *precentralis* on each side; these appear to be rather fainter than the occasional indications of such a furrow in *P. monachus* and *P. satanas*.

The *sulcus lateralis* (or *intraparietalis*) is curved like the letter "S," only in the reverse direction. Its anterior end is situated almost exactly midway between the fissure of Rolando (*centralis*) and the Sylvian. It is a little more extensive on the left side, where it ends rather nearer to the middle interhemispherical sulcus. Posteriorly this sulcus is quite unconnected with the *sulcus transverso-occipitalis*, as will be seen by an inspection of the accompanying figure (text-fig. 286, p. 930).

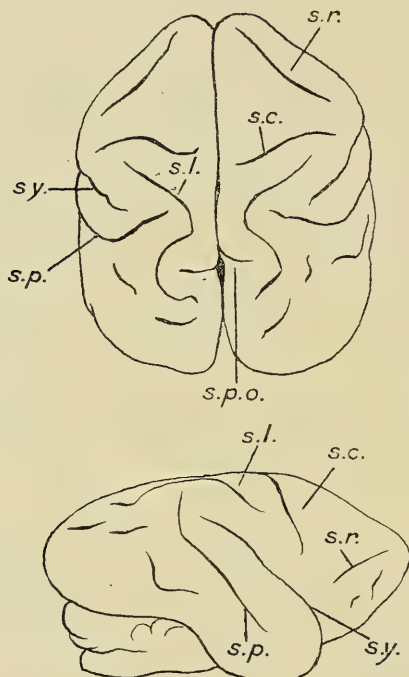
The *sulcus parieto-occipitalis* appears for some distance upon the dorsal aspect of the brain, and the two furrows right and left have to each other exactly the reverse relation to that which is shown in the same furrows in *Pithecia monachus* by both Flower and Elliot Smith. In the latter the left-hand furrow lies rather in front of the right, while in the brain of *P. pithecia* examined by myself the right-hand furrow is distinctly in advance of the left. This position of the parieto-occipital fissure is obviously related to the asymmetry shown by the lateral fissure, since in both hemispheres the parieto-occipital exactly divides into two the area of brain partly enclosed by the semicircle formed by the posteriorly situated half of the lateral fissure.

The *Sylvian* fissure has the same relations to the *postsylvian*, or *parallel* fissure, that it is represented to have in the specimen of the brain of *P. monachus* figured by Elliot Smith in the "Catalogue of the Royal College of Surgeons Museum"; that is to say, the two fissures incline towards one another superiorly though

they do not meet. They more nearly meet, however, on the right side than on the left.

The furrows on the mesial aspect of the hemispheres differ in some small details from the corresponding furrows figured by Flower and Elliot Smith in the brain of the species *Pithecia monachus*.

Text-fig. 286.



Brain of *Pithecia pithecia*.

The upper figure represents the dorsal aspect, the lower figure the right-hand lateral aspect.

s.c. Sulcus centralis. s.l. Sulcus lateralis. s.p. Postsylvian fissure. s.p.o. Sulcus parieto-occipitalis. s.r. Sulcus rectus. s.y. Sylvian sulcus.

The *mesial parieto-occipital* fissure differs rather on the two hemispheres; it is much deeper as well as longer on the left side than on the right. The furrow is nearly vertical to the longitudinal axis of the hemisphere, and at the lower end inclines slightly forward on the left hemisphere and slightly backwards on the right. It was not double as it is indicated to be in *Pithecia monachus* by Elliot Smith.

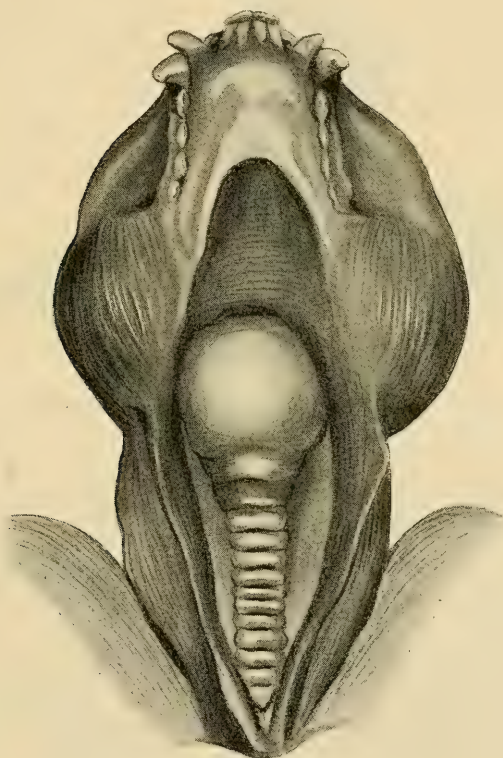
The *calcarine* fissure also differs on the two sides of the brain. In that of the right hemisphere the anterior limb of the Y is very

much reduced in length, as is represented to be the case in Flower's figure (5, p. 330, fig. 4 *b*) of the mesial aspect of the brain of *P. monachus*. The backwardly running part of the Y, which is parallel to the surface of the hemisphere, is very much the longer. This part of the calcarine complex is moreover much nearer to the surface of the brain than is that of the left hemisphere.

§ *Larynx and Trachea.*

The accompanying drawing (text-fig. 287) represents the larynx and a portion of the trachea of *Pithecia pithecia* shown in due relation to the adjacent structures. The body of the hyoid is

Text-fig. 287.

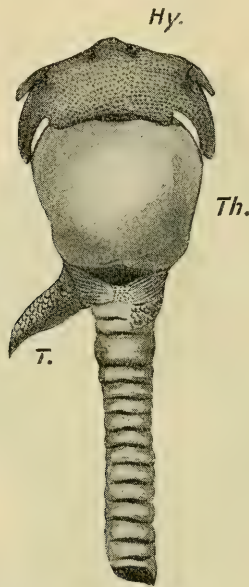


Larynx and a portion of the trachea of *Pithecia pithecia* seen *in situ* from the ventral surface.

not exposed, being covered by the platysma muscle which is represented as uncut. The enormously increased thyroid cartilage is seen to occupy a very large space between the rami of the

mandible. More than one half of the cartilage, however, lies posteriorly to the angle of the jaws. When the hyoid body is exposed by cutting the superjacent muscles of the throat it is seen to lie close to and even in contact with the thyroid cartilage. The thyro-hyal ligament of course exists, and the hyoid can by stretching be removed from its contiguity to the thyroid cartilage of the larynx. But when the tension is relaxed the bone and the cartilage are again brought into contact. It is especially to be noted that there is no dilatation of the hyoid such as occurs in *Mycetes*; the bone in *Pithecia pithecia* is of quite normal form.

Text-fig. 288.

Hyoid and larynx of *Pithecia pithecia* viewed from the ventral surface.

*Hy.* Hyoid. *T.* Thyroid body. *Th.* Thyroid cartilage of larynx.

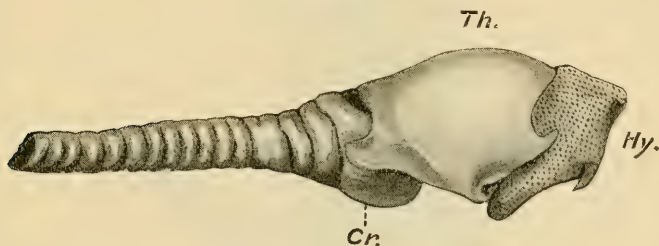
Sir W. Flower's account of the anatomy of *Pithecia monachus* (5), which touches upon most of the viscera, contains no mention of the laryngeal structures, with which species therefore I am not able to compare *Pithecia pithecia* in this respect. The thyroid cartilage, as already mentioned, is very large. It is of spherical aspect and measurements confirm this; the length was 20 mm. and the breadth 21 mm. The texture of the inflated bulla shows that it is entirely cartilaginous. I could find no ossification anywhere. The animal, it is to be recollected, is a male. It is important to take notice of the facts which have just



been mentioned, since the late Prof. Weldon observed (14) in a female monkey of the genus *Callithrix* not only that the thyroid cartilage was swollen but that there was a patch of ossification on each side, which facts "seem to show the possible existence of a howling apparatus in the male."

It is obvious, however, from Weldon's figure of the larynx of *Callithrix gigot* (14, p. 9, fig. 4), that the thyroid cartilage, if "swollen," is relatively small to the rest of the cartilage and bones in the neighbourhood, when compared with *Pithecia*. So large and swollen is this cartilage in *Pithecia pithecia* that there is hardly any thyroid notch along the upper ventral border where the cartilage is in contact with the body of the hyoid, nor is there any marked "Adam's apple." The whole surface of the cartilage ventrally is uniformly convex. The proportion between the thyroid and cricoid pieces of the larynx and the body of the hyoid are to be seen in the figure of the isolated larynx seen from the ventral aspect (text-fig. 288). Although the thyroid

Text-fig. 289.

Hyoid and larynx of *Pithecia pithecia* viewed laterally.

Cr. Cricoid cartilage. Other letters as in text-fig. 288.

cartilage is smooth and almost bubble-like when viewed from the ventral aspect, it is flattened and ridged laterally where the thyrohyoid muscle is attached. As in *Callithrix* (cf. Weldon), the anterior and posterior cornua of the thyroid cartilage are not very pronounced. The posterior cornu is the most conspicuous. So far it is clear that *Pithecia* resembles *Callithrix* more nearly than it does *Myrcetes* \*. The cricoid is ossified in the middle line ventrally, which fact is indicated by dots in the accompanying figures (text-figs. 288 & 289) of the larynx of *Pithecia pithecia*. The lateral regions of the cricoid are not ossified. The lateral view of the laryngeal cartilages (text-fig. 289) may be compared with Weldon's figure of the same cartilages in *Callithrix*, when the differences in their proportions will be very apparent. The hyoid bones are correctly figured in the same drawings. The anterior cornu is cartilaginous. The tracheal rings present only one feature worthy

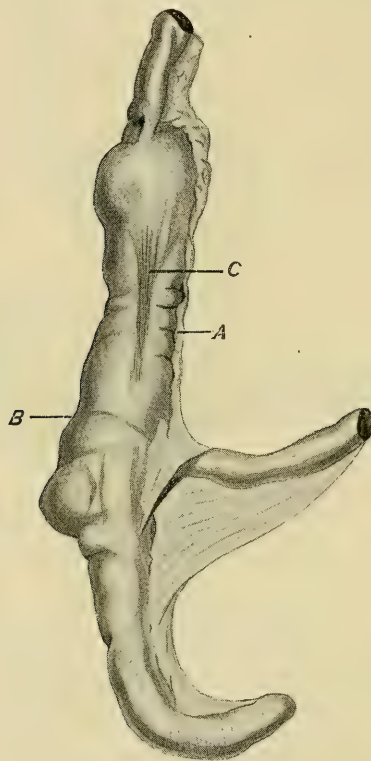
\* The larynx, &c. of this genus is figured by Wiedersheim in the 1886 edition of the *Vergleich. Anat. der Wirbelthiere*, p. 641.

of special notice—and that is the partial fusion of the third and fourth annuli, as is also shown in the figure to which reference has been made.

§ *Alimentary Viscera.*

The *tongue* measures 36 mm. in length and 14 mm. in breadth. The Mayer's organ on each side measures 8 mm. and is concave upwards; each organ consists of 10 or 11 folds. There are only

Text-fig. 290.



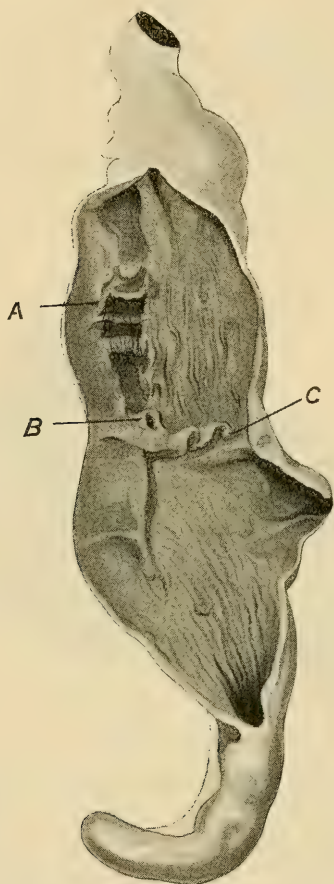
Cæcum and adjacent regions of gut of *Pithecia pithecia*.

- A. Sacculations of colon. B. Division between colon and cæcum.  
C. Band on colon related to sacculations.

three circumvallate papillæ disposed in the usual V. The fungiform papillæ amount to fourteen or fifteen on each side, and all lie well in front of the circumvallate papillæ. On the right side is a single fungiform papilla just in front of the right-hand circumvallate papilla. There is not a corresponding one on the left side.

The general shape of the *stomach* calls for no particular comment. It does not appear to me that the cardiac and pyloric orifices are much approximated, as Flower has stated them to be in *Pithecia monachus*.

Text-fig. 291.



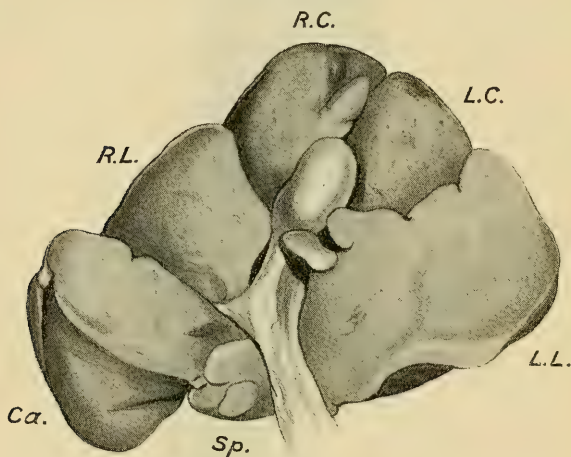
Caecum and colon of *Pithecia pithecia* partly cut open to show internal structure.

A. Sacculations of colon shown as deep recesses. B. Opening of ileum.  
C. Caeco-colic valve.

The *small intestine* measures 40 inches, the *colon* and *rectum* together 14, and the *caecum* 3 inches. The proportions are thus rather different from those of *Pithecia monachus* as described by Flower, in which species the small intestine is 50 and the large intestine 22 inches. From some manuscript notes left by the late

Mr. W. A. Forbes, I find that the proportions of the various regions of the alimentary tract of *Pithecia albinasa* are again very different. The small intestine in a female of that species was  $87\frac{3}{4}$  inches long and the large intestine  $12\frac{1}{2}$  inches. Some measurements of the two species *P. monachus* and *P. satanas* are given by Mr. Forbes in his paper upon the Ouakari Monkeys already quoted here. When the body of the monkey was opened the *omentum* was seen to extend right down the abdominal cavity. It is attached for the length of an inch and a quarter to the end of the ascending and the beginning of the transverse colon. The commencement of the omental attachment to the colon is situated about  $1\frac{1}{2}$  inch from the ileo-cæcal valve. The relations of the omentum to the colon appear to vary considerably among the Primates.

Text-fig. 292.

Liver of *Pithecia pithecia* seen from abdominal surface.

Ca. Caudate lobe. L.C. Left central lobe. L.L. Left lateral lobe.  
R.C. Right central lobe. R.L. Right lateral lobe. Sp. Spigelian lobe.

The *cæcum* (see text-fig. 290, p. 934) shows a fixed and uniform curve of a semicircle. The frænum attaching it to the ileum extends to within a sixth or an eighth of an inch from its extreme end. It is marked off from the colon by a distinct oblique groove, and the commencement of the *cæcum* is of slightly greater calibre than the adjoining colon. The cæco-colic valve, which corresponds of course to the constriction distinguishing the *cæcum* and colon, superficially extends for rather more than halfway round the periphery of the gut. A dense mass of tissue projecting into the colon from about the middle of this bears the origin of the ileum.



The first two inches of the *colon* are sacculated, and the very deep sacculations are shown from the inside in the illustration (text-fig. 291, p. 935). There were three of these, the first being larger than the two following. Along one side of this sacculated region of the colon was a distinct tenia, but not on the other.

The *liver* is represented in text-fig. 292 from the abdominal aspect. It will be seen to present no very remarkable features, and is very like those of other Platyrrhine Monkeys, e.g. *Callithrix* (see Beddard, 1, pl. xi. figs. 1, 2). The left lateral lobe gives off to the right two subsidiary outgrowths, of which one covers over the cystic duct and nearly touches the right lateral lobe\*. The well marked Spigelian lobe is divided into three lobules. The *bile-duct* joins the *cystic duct* about half an inch from their common orifice into the duodenum. There is practically no *hepato-renal ligament*, and the *hepato-caval ligament* is very short, lying just above the right kidney and not extending as far down as it. These ligaments agree according to my experience with the corresponding ligaments of *Cebus flavescens*.

#### § Heart and Blood-vessels.

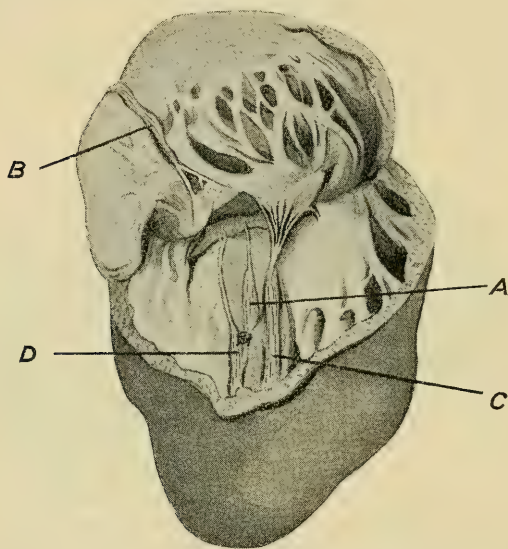
The accompanying illustration (text-fig. 293, p. 938) exhibits the interior of the right ventricle with the auriculo-ventricular valve and the papillary muscles attached thereto. The free wall of this ventricle is beautifully sculptured, the sculpturing being in excess of that which is sometimes met with in the same wall of the right ventricle of other mammals. I do not, however, wish to be understood as suggesting that this very marked sculpturing of the free ventricular wall is a character of the species or of the genus. The sculpturing forms a basketwork towards the middle of the wall of this ventricle; superiorly, near to where the auriculo-ventricular valve takes its origin, five or six strap-like bands free themselves altogether from the meshwork and run approximately parallel to each other to end upon the attached margin of the valve. The three cusps of the tricuspid valve itself are each provided with a papillary muscle, all of which are shown in the figure referred to. The middle papillary muscle arises, as is sometimes the case in other mammals, from the free wall of the ventricle. In common with the moderator band arises a slender papillary muscle which ends in chordæ tendineæ attached to the septal half of the valve collar; and another papillary muscle, also ending in connection with the septal half of the valve collar, lies close by and is also indicated in the accompanying text-figure.

The precise arrangement of the intercostal arteries varies so much among mammals that it is always worth while to describe

\* This almost free flap of hepatic tissue occurs in several monkeys. I have myself recorded it in *Callithrix* (as has Weldon) and in the ally of the present species, *Pithecia albinasa* (3, p. 364).

them in any particular type with a view of gathering material for a future generalisation. In *Pithecia pithecia* the arteries in question arise from the aorta by paired orifices, as is shown in the accompanying figure (text-fig. 294 A). In previous descriptions of the intercostal arteries of a few mammals, I have described the whole series of arteries which arise from the aorta on the dorsal surface behind the origin of the great vessels of the neck and in front of the cœliac and renal arteries. These arteries undoubtedly form a morphological series, though one or two of the more anterior really are bronchial arteries, being the nutritive arteries of the lungs. It is, however, impossible to

Text-fig. 293.



Interior of right ventricle of *Pithecia pithecia*.

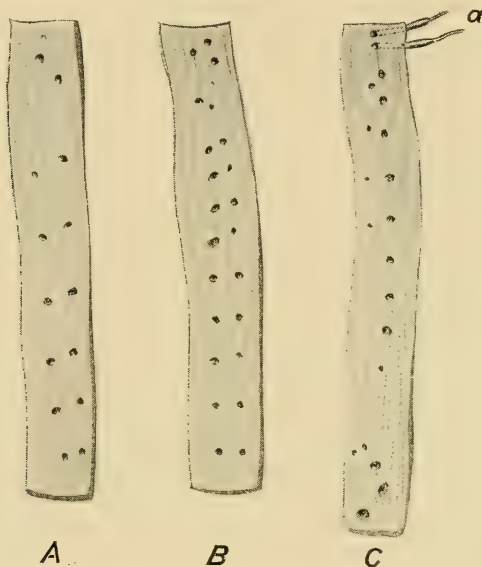
A & D. Papillary muscles of septal half of valve.

B & C. Papillary muscles of outer flap of valve.

draw a hard and fast line between such arteries as are distributed to the lungs and those which supply the dorsal parietes and are thus more accurately to be termed intercostals. For some of the arterioles which go to the lung tissue arise from intercostals, while others are undoubtedly independent. A further proof of the impossibility of absolutely distinguishing the two is to be seen in the case of *Colobus guereza*, the intercostals of which will be described later; and I refer to the ensuing description of the arteries of that species. Taking this view, the first three

arteries of the series now under consideration in *Pithecia pithecia* form a triangle with the apex pointing to the right, then follow six pairs of arteries, the orifices of which are rather obliquely set with reference to each other and which are rather wide apart. Thereafter the intercostal arteries are more symmetrical and perhaps closer together.

Text-fig. 294.



The commencing aorta of several Monkeys cut open to expose the origins and arrangement of the intercostal arteries, for an explanation of which see text.

A. *Pithecia pithecia*. B. *Cebus fatuellus*. C. *Colobus guereza*.

For the purpose of comparison, I have examined the corresponding arteries in the New World Monkey, *Cebus fatuellus*. There is a general correspondence with *Pithecia*, but differences of detail. Thus the triangle of presumably bronchial arterioles (text-fig. 294 B) is nearly the same. After this is a series of five pairs of intercostals which are closer together than in *Pithecia*, but oblique in the same fashion with the exception of the first pair which are oblique in the reverse direction, the right-hand artery being in advance of the left-hand artery. After this series the intercostals become symmetrical, and there are four pairs of these in front of the celiac artery. An example of *Colobus guereza* came to hand at the time that I was engaged in studying the anatomy of *Pithecia pithecia*, and I have drawn up some notes upon its intercostal arteries with a view of comparison on the points dealt with in the present communication. Naturally there are

differences, and this West African Monkey differs more from *Cebus* and *Pithecia* than are those two genera from each other. The intercostal series (text-fig. 294 C) are single arteries in their origin, and only divide later to form the two intercostals of the two sides of the body. The first two arteries of the series are closer together than those which succeed, and I ascertained that they are bronchial arteries, for I succeeded in tracing them into the tissue of the lung. As I have already mentioned, the condition of these arteries furnishes another argument in favour of regarding the whole series of arteries as forming morphologically one series. For each of these first two arteries was fully as large an artery as the intercostals proper. The artery in each case continued for some distance of the same calibre and then suddenly diminished in calibre to a slender twig running to the lung tissue. It looks indeed as if at the point of sudden diminution in calibre there was originally an intercostal arising here which has become aborted. And this seems to be the most probable explanation of the anatomical fact which is illustrated in the accompanying figure (text-fig. 294 C, a). The number of intercostals in this animal was nine after the two bronchials already referred to. All of these followed each other at approximately equivalent intervals. The first five were provided with a small arteriole to the right side, which I do not regard as a small additional intercostal, but as an œsophageal artery. After the ninth intercostal there was a considerable vacant space, and then just in front of the large visceral trunks a single pair of intercostals; in this region, therefore, alone are the intercostals paired trunks.

I fancy that the Primates generally will prove to possess invariably a right *azygos* only; though, indeed, materials for forming an opinion upon this point do not exist to any great extent. My own experience, however, points in that direction; and in any case *Pithecia pithecia* has an *azygos* upon the right side only which gives off nine branches. Of these the second, which is correspondingly bifurcate, supplies two intercostal spaces. I have a note by Mr. Forbes as to the *azygos* of *Pithecia albinasa* which he describes as "trifid," meaning, I take it, that the anterior two branches are of equal calibre with the main longitudinally running trunk.

Although I found the kidneys to be pretty well symmetrical, the left *renal* vein flowed into the postcaval at a point a little above the right renal vein—a converse asymmetry being the rule among Mammals. This state of affairs appears to agree with that recorded for *Pithecia monachus* by Flower (5, p. 332), who remarks that the right kidney is placed slightly lower than the left. On the other hand Forbes records the converse conditions in *Pithecia albinasa*. As in other Primates, the right *spermatic vein* flows into the postcaval a little below the right renal, while the left spermatic enters the left renal. I may take this opportunity of stating that in *Colobus guereza* the spermatic and renal veins were precisely as in *Pithecia pithecia*.



§ *Lungs and Spleen.*

Finally, I have to record that the right *lung* consisted of four lobes and the left of two only; and that the spleen was long and narrow,  $3\frac{1}{4}$  inches in length by  $\frac{1}{2}$  inch greatest breadth.

(2) *Some Notes upon Pithecia monachus.*

Since writing the above I have had the opportunity of dissecting an example of *Pithecia monachus*, which died in the Society's Gardens on Dec. 11th, 1909. It was a young male, and I have therefore been able to compare very particularly the structure of the larynx with that of its congener.

Generally speaking, I quite confirm the account of the anatomy of this species by the late Sir William Flower to which I have referred in my description of *Pithecia pithecia*. There are, however, certain details to which he has not referred, and I am able to compare the two species in respect of these and of other points.

The tongue appears to be almost exactly the same as in *Pithecia pithecia*. The three circumvallate papillæ are present, and, as in *P. pithecia*, the fungiform papillæ are mainly upon the flat lip of the tongue extending backwards along its sides, the middle dorsal surface of the tongue being free from them. A prominent fungiform papilla lies just in front of each lateral circumvallate papilla. In *P. pithecia*, as already noted, there is only this fungiform papilla on one side. Mayer's organ is equally conspicuous and of about the same size in the two tongues.

The palatal ridges differ slightly in the two monkeys, showing at the same time a general agreement. There are in both eight ridges on each side of the palate of which the anterior series of four are more complete than the posterior series.

I found that the proportions of the intestine in this young male were rather different from those described by Flower in a young female\*. In my specimen the small intestine was 42 inches, the colon and rectum 14 inches, and the cæcum  $1\frac{1}{2}$  inch. In Flower's specimen the same measurements were 50 inches, 22 inches, and  $4\frac{1}{2}$  inches.

I have figured on a previous page the interior of the cæcum of *Pithecia pithecia*. That of *P. monachus* is rather different, except of course in essentials. The same valve separates the cæcum from the colon, and the ileum opens on to the colic side of this raised fold. But in *P. monachus* there are none of the complications shown in the colon (*i. e.* the series of deep depressions) of *P. pithecia*. The internal surface of both colon and cæcum is quite smooth and even.

The omentum extends right down the abdominal cavity, and is attached for the distance of barely an inch to the ascending and

\* The size of the two specimens appears to be about the same, *i. e.* 11 inches of body.

transverse colon, this attachment commencing about an inch and a quarter beyond the entry of the ileum into the colon. The hepato-caval ligament is small, and at its extremity remote from the liver just strays on to the kidney on one side and on to the mesocolon on the other.

The postcaval vein and its branches are exactly as I have described them in *Pithecia pithecia*.

The intercostal system of arteries however differs. As in *P. pithecia*, there are first of all three branches which are presumably œsophageal and pulmonary in distribution. The first two intercostals are unpaired at their origin, and the subsequent series though paired are much closer together than in *Pithecia pithecia*. Whether this is really a specific difference remains of course to be proved.

I naturally paid very particular attention to the larynx of this species for purposes of comparison with the rather abnormal larynx of *Pithecia pithecia*, and discovered some differences which however may be due to the greater immaturity of my example of *Pithecia monachus*. In this specimen in fact the two posterior molars of each side of each jaw were quite invisible, there being thus only four grinding teeth present out of a total of six on each side of each jaw. The canines were considerably smaller than those of the *Pithecia pithecia*, in which all the molars were present.

In general aspect the larynx of this monkey was like that of *Pithecia pithecia*, but considerably smaller. This must be due to youth, to some extent at any rate; for the interspace between the rami of the lower jaw was less in this *Pithecia* than in the other. The diameter of this interspace measured at the beginning of the ascending part of the mandible was 34 mm. in *P. pithecia*, and 28 mm. in *P. monachus*. The mandible is, however, altogether much smaller in the *P. monachus*. But while the two individuals differ in actual size and in the size of the parts adjacent to the larynx, there is nothing like such an enormous difference as that which exists between the larynges of the two species of *Pithecia*, for the thyroid cartilage in *P. monachus* measures only 9 mm. in length by 12 mm. in breadth. It is therefore about half the size of that of *P. pithecia*. The proportions of length and breadth are also, it will be observed, rather different. The thyroid is broader in the younger *P. monachus*. This may be a specific difference. I regard as a sign of immaturity the form of the thyroid cartilage. In the adult *Pithecia pithecia* it will be remembered that the ventral surface of the thyroid is smooth and rounded. In the present species there is anteriorly but not posteriorly a distinct though low median ridge, thus preserving the more usual form of the thyroid cartilage in Mammals. This ridge easily escapes the eye owing to the fact that it is but little pronounced. It is nevertheless present. It is quite easy to suppose that the subsequent growth of the thyroid

cartilage might obliterate this ridge and lead to the conditions observable in the adult *Pithecia pithecia*. On the other hand, no positive facts exist with reference to the growth of the larynx in any *Pithecia*, and it may well be that the differences which I am describing are actually specific differences after all.

The body of the hyoid, I may remark, is quite as large and as well ossified as in *P. pithecia*.

*List of Literature referred to.*

- (1) BEDDARD, F. E.—On Certain Points in the Anatomy of *Callithrix torquata*. Novit. Zool. viii. 1901, p. 362.
- (2) BEDDARD, F. E.—On *Brachyurus calvus*. P. Z. S. 1887, p. 119.
- (3) BRADLEY, D. C.—On the Abdominal Viscera of *Cercocebus fuliginosus* and *Lagothrix humboldti*. Proc. Roy. Soc. Edinb. xxiv. 1903, p. 505.
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- (4) FLATAU & JACOBSON.—Handbuch der Anatomie und vergleichenden Anatomie des Centralnervensystems der Säugethiere, Vol. i. Berlin, 1908.
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- (9) KUKENTHAL & ZIEHEN.—Untersuchungen über die gross-hirnfurchen der Primaten. Jen. Zeitschr. xxix. 1895, p. 1.
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- (13) TURNER, W.—The Convolutions of the Brain. J. Anat. Phys. xxv. 1891, p. 236.
- (14) WELDON, W. F. R.—Notes on *Callithrix gigot*. P. Z. S. 1884, p. 6.

8. On the Ophidian Genus *Grayia*.

By G. A. BOULENGER, F.R.S., V.P.Z.S.\*

[Received October 29, 1909.]

(Text-figures 295-299.)

The progress in our knowledge of African Snakes due to increased material has shown the genus *Grayia*, established by Dr. Günther in 1858 †, to be much in want of revision. The discovery of *Grayia tholloni* has so completely bridged over the gap separating this genus from *Xenurophis* Günther, that I no longer think the latter can be maintained. The two species *Grayia smithii* Leach, and *Grayia furcata* Mocq., which I retained as distinct in the Catalogue of Snakes (vol. ii., 1894) were erroneously characterized, and the name of the latter has to be altered to that of *ornata* proposed at an earlier date by Barboza du Bocage. Thanks to the courtesy of my friend and colleague Prof. Dollo, C.M.Z.S., I have received the loan of the type specimen of his *Grayia giardi*, the true affinities of which I had overlooked, and which I am now convinced should be referred to the synonymy of *Tropidonotus olivaceus* Peters. Another species more recently described as *Grayia lubrica* W. Slater, Ann. S. Afr. Mus. i. 1898, p. 109, must also be withdrawn as synonymous with *Tropidonotus lævissimus* Günther, the habitat of which long remained unknown, but of which I have recently received a specimen from Natal through Dr. E. Warren.

The genus *Grayia*, after these eliminations, embraces four species—*G. ornata*, *G. smithii*, *G. tholloni*, of which revised descriptions are here given, and *G. cesar*.

## GRAYIA ORNATA.

*Macrophis ornatus* Bocage, Journ. Sc. Lisb. i. 1866, p. 67.

*Glaniolestes ornatus* Peters, Mon. Berl. Ac. 1877, p. 614.

*Grayia furcata* Mocquard, Bull. Soc. Philom. (7) xi. 1887, p. 71; Bouleng. Cat. Sn. ii. p. 287 (1894).

*Grayia triangularis* (non Hallow.), Günth. Ann. & Mag. N. H. (6) i. 1888, p. 325.

*Grayia smithii*, part., Bouleng. Cat. Sn. ii. p. 286; Werner, Verh. zool.-bot. Ges. Wien, xlix. 1899, p. 138; Bouleng. Proc. Zool. Soc. 1900, p. 453; Sternfeld, Mitth. Zool. Mus. Berl. iv. 1908, p. 231.

\* Published by permission of the Trustees of the British Museum.

† The name *Grayia* might be objected to as preoccupied in Zoology; it had long ago been changed by Cope (*Glaniolestes*) on the ground of its preoccupation in Botany. However, on referring to the zoological paper in which the prior use of the name occurs (C. R. Ac. Sci. xliii. 1856, p. 841), I find that *Grayia*, Bonaparte, is merely a *nomen nudum* for a subgenus of *Palapteryx*, Owen.

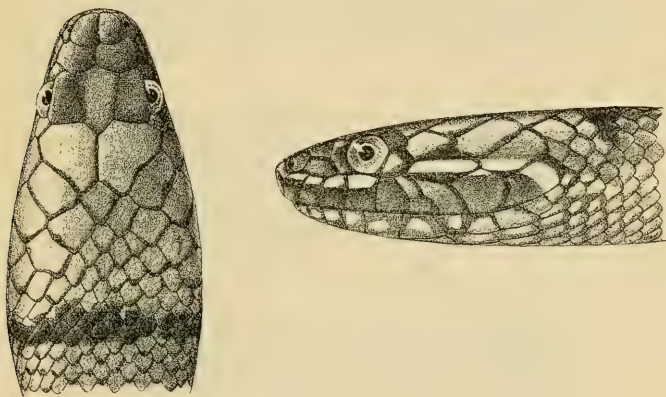


*Grayia ornata* Bocage, Herp. Angola, p. 104 (1895); Mocquard, Bull. Soc. Philom. (8) ix. 1897, p. 8.

*Grayia smythii* (non Leach) Sternfeld, Mitth. Zool. Mus. Berl. iv. 1908, p. 409.

Eye moderate in the adult, shorter than its distance from the nostril, as long as its distance from the oral border, larger in the young. 22 to 27 maxillary teeth on each side. Rostral once and a half to once and two-thirds as broad as deep, just visible from above; nasal divided or semidivided; internasals as long as broad or a little longer, as long as or a little shorter than the præ-frontals; frontal once and a half to twice as long as broad, as long as or a little longer than its distance from the end of the snout, as long as or slightly shorter than the parietals; loreal once and

Text-fig. 295.



Head of *Grayia ornata*.

one-third to twice as long as deep\*; one præ- and two post-oculars; temporals 2+3, lower anterior not longer than its distance from the loreal; eight upper labials, fourth entering the eye (rarely nine, third and fourth entering the eye†), the last about as long as the two preceding combined; one or several of the labials behind the eye usually divided into two, a small triangular shield being often intercalated between the fifth and sixth labials‡; four or five lower labials in contact with the anterior chin-shields, which are not or but slightly shorter than the posterior. Scales in 17 to 20 rows on the body, usually 19, in 6 rows on the greater

\* Absent on the right side in spec. 13 (Kasayo, Congo).

† In one specimen, No. 5 (Assobam, Cameroon); the type of *G. triangularis* is also described as having nine upper labials.

‡ No division of the upper labials in a specimen from Bitye (No. 3).

part of the tail. Ventrals 143-157; anal divided; subcaudals 71-84.

As regards the coloration, this species appears to fall into two principal forms—the typical, originally described from Duque de Bragança, Angola, and Mocquard's *G. furcata*, from Brazzaville, Congo, which Bocage also records from Duque de Bragança, and which seems to be the common form in Cameroon and the Gaboon.

*G. ornata* is thus described by Bocage from a specimen 1640 millim. in length:—Olive above, with numerous irregular deep black spots, confluent on the tail and the posterior third of the body, much better separated on the middle third, and again confluent on the anterior third, where they form a broad longitudinal band from the occiput to a distance of about 150 millim.; two parallel black bands along the side of the anterior third of the body, the upper the broader, extending from the first upper labial, the lower extending from the third ventral shield; head olive above, irregularly spotted with black, the lateral shields edged with black; two black streaks on the temporal region; greenish yellow beneath, the shields spotted and edged with black.

A specimen from the Gaboon in the British Museum (no. 12) appears to represent the young of the typical *G. ornata*. It is dark brown above, with black spots having a tendency to form longitudinal lines; the sides of the head and of the body, and the lower parts are black; two broken-up white lines along the sides, the upper the better developed and extending over the temple to the eye; some white spots on the labial shields and under the head; tail and posterior part of body uniform black.

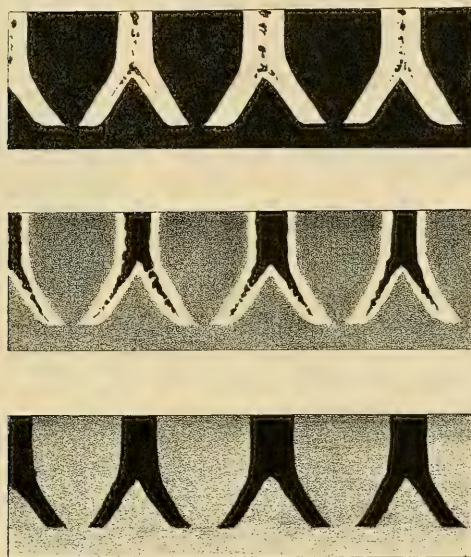
Mocquard's *G. furcata* is based on a specimen a little over a metre in length, greyish brown above, with 25 black cross-bars, not half as broad as the spaces between them, these bands bifurcating towards the ventrals, the sides showing very regular A-shaped black figures; the body turns to a uniform blackish brown towards the tail; ventral region dirty white in front, blackish brown towards the tail, which is black above and blackish brown beneath; the upper head-shields are blackish brown, except the parietals, which are fulvous edged with black; sides and lower surface of head grey, the shields edged with black.

This description applies tolerably well to specimens from South Cameroon, the Gaboon, and Central Africa, in the British Museum. The back bars number 21 to 25, exclusive of such as may be present on the tail, which is not always black; the parietals are more or less distinctly lighter in colour than the other head-shields, the sides of the head are brown or blackish with white spots on the labials and temporals, those behind the eye corresponding to the white line shown by the young specimen of the typical form mentioned above; the belly is yellowish or greyish white, at least the posterior ventral shields spotted, freckled, or edged with black. A specimen from the Gaboon

(no. 11) is almost uniform brown above, the darker cross-bars being very indistinct and not forked on the sides.

Young specimens are very remarkable in showing an inversion of the markings of *G. furcata*, or rather, as pointed out by Dr. Mocquard, being the negative of what is considered the positive in the adult. The snake may be described as black with light, whitish, or greyish cross-bands (15 to 32 in number), bifurcating on the side. I have long been at a loss to explain how the change takes place, but I have now succeeded in bringing

Text-fig. 296.



Side view of body of *Grayia ornata*.

Diagrams showing changes in markings with age.

together enough material of different ages to throw satisfactory light on this point. The black ground-colour gradually passes to grey or brown, whilst a black bar develops and enlarges within the light bars of the young, which later become reduced to a narrow white margin to the former and finally disappear. The three diagrams (text-fig. 296) will explain the change better than a lengthy description.

The largest specimen examined by me measures 1030 millim. ; tail 260.

This species is known from Cameroon, the Gaboon, the Congo, and Angola.

*List of the specimens in the British Museum.*

1. Hgr. ♀.	Sc. 20; V. 154; C. ?	Efulen, S. Cameroon.	G. L. Bates, Esq. (C.).
2. ♂.	Sc. 19; V. 161; C. ?	Bitye,	" "
3. Hgr. ♂.	Sc. 17; V. 145; C. 83.	" "	" "
4. ♀.	Sc. 19; V. 157; C. 71.	" "	" "
5. Yg.	Sc. 17; V. 152; C. 79.	Assobam,	" "
6. Yg.	Sc. 20; V. 147; C. 84.	Benito R., Spanish Guinea.	" "
7. ♂.	Sc. 19; V. 145; C. 79.	Ogowe, Gaboon.	Dr. W. J. Ansorge (C.).
8. Yg.	Sc. 19; V. 143; C. ?	Nehali, nr. Fernan Vaz.	" "
9. Yg.	Sc. 19; V. 153; C. 80.	Lambarene, Ogowe.	Miss Kingsley (C.).
10. Yg.	Sc. 19; V. 145; C. ?	Sette Cama, Gaboon.	" "
11. ♂.	Sc. 19; V. 147; C. ?	Gaboon.	" "
12. Yg.	Sc. 17; V. 147; C. 82.	" "	" "
13. Hgr. ♀.	Sc. 17; V. 143; C. 71.	Kasayo, Congo.	Dr. J. L. Todd (P.).
14. Yg.	Sc. 17; V. 148; C. 74.	Congo.	" "
15. ♂.	Sc. 19; V. 150; C. 83.	C. Africa.	Warrington Museum (E.).

## GRAYIA SMYTHII.

*Coluber smythii* Leach, in Tuckey's Explor. R. Zaire, App. p. 409 (1818).

*Coluber levis* (non Lacep.), Hallow. Proc. Ac. Philad. 1844, p. 118.

*Coronella triangularis* Hallow. Proc. Ac. Philad. 1854, p. 100.

*Heteronotus triangularis* Hallow. Proc. Ac. Philad. 1857, p. 68.

*Grayia silurophaga* Günth. Cat. Col. Sn. p. 51 (1858); F. Müll. Verh. Nat. Ges. Basel, vii. 1885, p. 683.

*Leionotus schlegeli* Jan, Elenco Ofid. p. 68 (1863), and Arch. Zool. Anat. Phys. iii. 1865, p. 241.

*Grayia triangularis* Bocage, Journ. Sc. Lisb. i. 1866, p. 47; Boettg. Ber. Senck. Ges. 1887-88, p. 51; Bocage, Herp. Angola, p. 102 (1895).

*Grayia smythii*, part., Bouleng. Cat. Sn. ii. p. 286 (1894); Werner, Verh. zool.-bot. Ges. Wien, xlix. 1899, p. 138; Bouleng. Proc. Zool. Soc. 1900, p. 453; Sternfeld, Mitth. Mus. Berl. iv. 1908, p. 231.

*Grayia smythii* Günth. Ann. & Mag. N. H. (6) xv. 1895, p. 525.

Eye rather small in the adult, shorter than its distance from the nostril, as long as its distance from the oral border, larger in the young. 22 to 25 maxillary teeth on each side. Rostral once and one third to once and a half as broad as deep, just visible from above; nasal divided or semidivided; internasals as long as broad or a little longer than broad, as long as or longer than the præfrontals; frontal once and two thirds to twice as long as broad, longer than its distance from the end of the snout, as long as or a little shorter than the parietals; loreal as long as deep or a little longer; one præ- and two postoculars; temporals 2+3, lower anterior longer than its distance from the loreal, sometimes as long as its distance from the rostral; seven upper labials



(rarely eight through division of the last \*), seventh (if undivided) as long as the three preceding combined, fourth entering the eye; four or five lower labials in contact with the anterior chin-shields, which are shorter than the posterior. Scales in 17 rows on the body, in 6 or 4 rows on the greater part of the tail. Ventrals 145-168; anal divided; subcaudals 89-102.

Text-fig. 297.



Head of *Grayia smythii*.

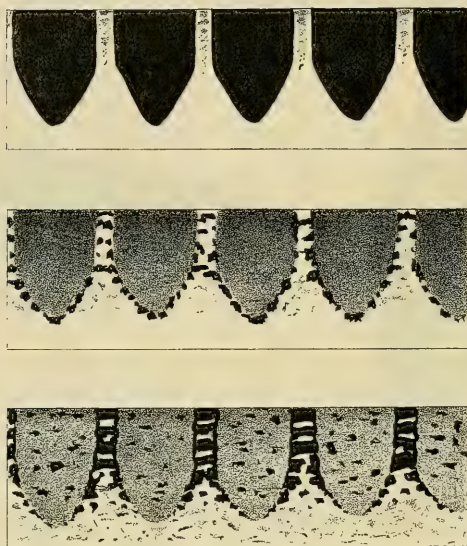
*Coloration of young.*—Dark brown or black cross-bars, each occupying 4 or 5 transverse series of scales on the upper part of the body, separated by narrow whitish or pale brown lines, less than a scale in width; these bands taper to a point or are rounded off at the sides, where they stand out boldly on the white colour which extends from the ventrals to the lower rows of scales; head pale brown above, upper lip white, the sutures between the shields dark brown or black; lower surface of head and body white, with or without a more or less regular series of small black spots on each side; lower surface of tail white, with a brown or black zigzag median line corresponding to the junction of the pairs of subcaudals. The dark cross-bars on the body number 36 to 39.

*Changes with age.*—The brown or black cross-bars of the young become generally lighter with age, turning to olive, greyish olive or brown, retaining the dark colour on their edges, so as often to form a zigzag line along each side, corresponding to the angles of the extremities of the cross-bars, the light triangles between them being often spotted with black; the light lines usually become converted into more or less regular series of black and yellowish spots. Some adult specimens, however, retain much

\* In specimens No. 3 (Sierra Leone) and 7 (Cameroon).

the same colour-pattern as the young, except that the light bars become divided and of a pale brown; others again differ in being spotted all over with black, or blackish, with lighter, yellowish, or pinkish spots or variegations. Head as in the young. Lower

Text-fig. 298.

Side view of body of *Grayia smythii*.

Diagrams showing changes in markings with age.

parts white, uniform or more or less spotted or freckled with black, often with a lateral series of round black spots; posterior ventrals and subcaudals often edged with black.

Grows to a length of 1650 millim.; tail 500.

Known from West and Central Africa and Uganda.

*List of the specimens in the British Museum.*

1. ♂.	V. 154; C. 101.	Labé, French Guinea.	Dr. E. Gendre (P.).
2. ♀.	V. 164; C. ?	"	"
3. ♂.	V. 148; C. 97.	Sierra Leone.	Sir A. Kennedy (P.).
4. Yg.	V. 158; C. 93.	Agberi, S. Nigeria.	Dr. W. J. Ansorge (C.).
5. Hgr.	V. 162; C. ?	W. Province, S. Nigeria.	A. E. Kitson, Esq. (P.).
6. ♂.	V. 154; C. 99.	Oil River, Cameroon.	Sir H. H. Johnston (P.).
7. ♀.	V. 161; C. 89.	"	"
8. ♀.	V. 161; C. ?	Cameroon, opposite Fernando Po.	Mrs. Burton (P.).
9. Yg.	V. 150; C. ?	Mouth of the Loango.	Mr. Duggan (C.).

10. Hgr. ♀.	V. 147; C. 93.	Boma, Congo.	Dr. Leach (P.). (Type of <i>C. smythii</i> and of <i>G. silurophaga</i> .)
11. Yg.	V. 160; C. 94.	Zambi, Lower Congo.	Capt. Lepez (C.).
12. ♀.	V. 163; C. 94.	Leopoldville, Congo.	Dr. J. L. Todd (P.).
13. ♀.	V. 159; C. 96.	Monsembe, Upper Congo.	Rev. J. H. Weeks (P.).
14. ♂.	V. 147; C. 98.	District of Victoria Falls.	M. J. Capart (P.).
15. Yg.	V. 155; C. 95.	" "	" "
16. Yg.	V. 152; C. 91.	" "	" "
17. ♀.	V. 161; C. 94.	Entebbe, Uganda.	Sir H. H. Johnston (P.).
18. ♀.	V. 168; C. ?	" "	Mr. E. Degen (C.).
19. Head & tail.		Uganda.	Dr. Scott Elliot (P.).
20. Hgr.	V. 151; C. 97.	— ?	} (Types of <i>G. silurophaga</i> .)
21. Hgr.	V. 149; C. 101.	— ?	

## GRAYIA THOLLONI.

*Grayia tholloni* Mocquard, Bull. Soc. Philom. (8) ix. 1897, p. 11; Bouleng. Ann. Mus. Congo, Zool. ii. 1901, p. 17; Werner, Rep. Wellcome Res. Labor. iii. 1908, p. 170.

*Grayia fasciata* Bouleng. t. c. p. 9, pl. iii. fig. 3.

Eye rather large, as long as its distance from the nostril, longer than its distance from the oral border. 27 to 30 maxillary teeth on each side. Rostral once and a half to once and two thirds as broad as deep, just visible from above; nasal divided\*; internasals as long as broad or a little longer, shorter than the

Text-fig. 299.

Head of *Grayia tholloni*.

præfrontals; frontal once and three fourths to twice as long as broad, longer than its distance from the end of the snout, as long as the parietals; loreal once and one third to once and a half as long as deep; one præ- and two postoculars; temporals 2 + 3 †, lower anterior not longer than its distance from the loreal; eight upper labials, fourth or fourth and fifth ‡ entering the eye;

\* Resting on the first labial only in the two type specimens, a character to which Mocquard attaches undue importance; the divided nasal rests on 2 labials in 3 out of the 4 specimens examined by me.

† Exceptionally  $\frac{1}{1+2}$  according to Mocquard.

‡ 4th and 5th entering the eye on the left side in a specimen from Barboi, on both sides in one from Entebbe.

four to six lower labials in contact with the anterior chin-shields, which are as long as or a little shorter than the posterior. Scales in 15 rows on the body, in 4 rows on the greater part of the tail. Ventrals 130-143\*; anal divided; subcaudals 100-128.

Young blackish above, with narrow white bars which are very distinct on the anterior half of the body and generally disappear further back; upper lip and lower parts white, the labial shields with black bars on the sutures, the ventral shields with a small black spot on the outer end. Only three of the light bars, bordered by black spots, are seen in the half-grown, and they may vanish completely in the adult, which is olive, with small black spots on the sides, and light outer edges to the scales; the black bars on the upper labials are very pronounced, and that between the last two extends upwards on the temporals.

The two type specimens are described as from the French Congo. A young specimen, type of *G. fasciata*, is from the south-west of Lake Tanganyika. The three following specimens are preserved in the British Museum. The largest measures 1200 millim.; tail 490:

1. Hgr. ♂.	V. 135; C. ?	Entebbe, Uganda.	Sir H. H. Johnston (P.).
2. ♀.	V. 143; C. 111.	Polkom, Baro R., (Sobat).	Mr. P. C. Zaphiro (C.); W. N. MacMillan, Esq. (P.).
3. ♂.	V. 134; C. ?	Barboi, White Nile.	Dr. Wenyon (C.); Dr. F. Werner (P.).

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\* 170, given by Werner, is probably a lapsus or misprint.



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- Sminthopsis  
   *murina*, 804, 842, 843,  
   845.  
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   659, 660.  
   *impar*, 611.  
   *vulgaris*, 649.  
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   *olivieri*, 790.  
   *religiosa*, 790.  
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   *bornœnsis*, 883.  
   *sinensis*, 883.  
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   *testudineus*, 771.  
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   *hypogæa*, 740.  
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   *bengalensis*, 769.  
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   *syndactylus*, 740.  
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   857, 878, 879.  
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   *glaberrima*, 705.  
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   *immaculatus*, 612.  
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   660.  
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   *amarantum*, 915.  
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   *cymodoce*, 705.  
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ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

May 11th, 1909.

Prof. E. A. MINCHIN, M.A., Vice-President,  
in the Chair.

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Mr. R. H. BURNE, M.A., F.Z.S., exhibited a series of specimens, from the Museum of the Royal College of Surgeons, of adaptive structures for the respiration of air in some Aquatic Invertebrates and tropical Freshwater Fishes.

Mr. R. I. Pocock, F.L.S., F.Z.S., the Superintendent of the Gardens, exhibited the skin of a monkey representing a new subspecies of *Cercopithecus*, brought by Capt. Boyd Alexander, F.Z.S., from Lake Chad. This he proposed to name *C. tantalus alexandri*, separating it from the typical *C. tantalus* from Nigeria because the whiskers were very long and almost wholly white, a character in which it approached the Abyssinian species *C. aethiops*.

Mr. W. F. H. ROSENBERG, F.Z.S., exhibited a Rook in which the upper mandible had overgrown the lower to a remarkable extent. This abnormality was evidently caused by an injury to the tip of the lower mandible having deprived the upper one of the opposing surface necessary to check its growth.

Prof. WILLIAM RIDGEWAY, M.A., read the following papers, communicated by the Secretary, entitled:—(a) "On hitherto unrecorded Specimens of *Equus quagga*"; (b) "Differentiation of the Three Species of Zebras"; (c) "On a Portion of a Fossil Jaw of one of the Equidæ"; and illustrated his remarks with a series of lantern-slides.

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\* This Abstract is published by the Society at 3 Hanover Square, London, W., on the Tuesday following the date of Meeting to which it refers. It will be issued, free of extra charge, to all Fellows who subscribe to the Publications, along with the 'Proceedings'; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

Mr. R. LYDEKKER described a female Deer skin obtained by Captain Malcolm McNeil from Sze-chuen, which he regarded as representing a race of the Hangul distinguished by its very pale colouring; for this the name *Cervus cashmirianus macneili* was suggested.

Mr. E. C. CHUBB, F.Z.S., presented a paper on "The Batrachians and Reptiles of Matabeleland," based upon specimens in the Rhodesia Museum, Bulawayo.

The next Meeting of the Society for Scientific Business will be held on Tuesday, the 25th May, 1909, at half-past Eight o'clock P.M., when the following communications will be made:—

1. Dr. J. G. DE MAN.—Description of a new Species of the Genus *Alpheus* Fabr. from the Bay of Batavia.

2. R. LYDEKKER.—On the Skull of a Black Bear from Eastern Tibet, with a Note on the Formosan Bear.

3. R. H. BURNE, M.A., F.Z.S.—The Anatomy of the Olfactory Organ of Teleostean Fishes.

The following communication has been received:—

G. C. SHORTRIDGE.—An Account of the Geographical Distribution of the Marsupials and Monotremes of South-west Australia, having special reference to the specimens collected during the Balston Expedition of 1904–1907.

Communications intended for the Scientific Meetings of the ZOOLOGICAL SOCIETY OF LONDON should be addressed to

P. CHALMERS MITCHELL,

*Secretary.*

3 HANOVER SQUARE, LONDON, W.

*May 18th, 1909.*



ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

May 25th, 1909.

Dr. S. F. HARMER, M.A., F.R.S., Vice-President  
in the Chair.

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The SECRETARY read a Report on the additions that had been made to the Society's Menagerie during the month of April 1909.

Mr. J. L. BONHOTE, M.A., F.L.S., F.Z.S., exhibited the skins of an example of a tetragen hybrid Duck of the  $F_2$  generation, which he had bred in his aviaries, and pointed out that the characters of this bird were a striking confirmation of the truth of Mendel's Law. Mr. Bonhote also exhibited a pair of pentagen hybrids of the  $F_2$  generation, which were interesting as showing to what extent cross-breeding could be carried among certain species, the hybrids proving fertile to at least the fourth generation since the last cross with a pure species.

Mr. L. HARDING COX, F.Z.S., exhibited a living specimen of the Amblystome or transformed Axolotl, and drew attention to the following distinguishing points of the terrestrial batrachian, viz.: alteration in dentition, possession of lungs and eyelids, absence of gills and crest, and variation in colour.

Mr. R. LYDEKKER exhibited the photograph of a young Stag from Sikhim, now living in Nepal, which he believed to represent

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the Shou (*Cervus affinis*), and, if so, to be the first picture of that Deer which had been submitted to the Society since Brian Hodgson's time.

Mr. R. LYDEKKER described the skull-characters of three local forms of the Southern Sea-Elephant (*Macrorhinus leoninus*). Of these the Falkland race, which might be inseparable from the Juan Fernandez *M. l. typicus*, had been named *M. l. falklandicus*, and is characterised by the length and flatness of the palate. In the Crozet race, for which the name *M. l. crozetensis* was suggested, on the other hand, the palate is sharp, wide, and concave. The Macquarie race, proposed to be called *M. l. macquariensis*, is somewhat intermediate in skull-characters between the other two.

Mr. R. LYDEKKER also directed attention to the skin and skull of a Black Bear obtained by Captain Malcolm McNeil in Eastern Tibet. The skull indicated a race of the Himalayan Black Bear characterised by the small size of the cheek-teeth; and for this race the name *Ursus torquatus macneili* was proposed.

Mr. R. H. BURNE, M.A., F.Z.S., read a paper on "The Anatomy of the Olfactory Organ of Teleostean Fishes," in which the chief structural variations were described in some fifty genera, mostly of common British species, illustrating the anatomical facts he presented by a series of coloured diagrams.

Dr. J. G. DE MAN presented a paper, communicated by Mr. R. I. Pocock, F.Z.S., entitled "Description of a New Species of the Decapod Crustacean Genus *Alpheus* Fabr. from the Bay of Batavia."

The next Meeting of the Society for Scientific Business (closing the Session 1908-09) will be held on Tuesday, the 15th June, 1909, at half-past Eight o'clock P.M., when the following communications will be made:—

Demonstration, with lantern-slides, of a Theory of Atoll Formation, by Dr. F. WOOD JONES, F.Z.S.

#### PAPERS.

1. F. E. BEDDARD, M.A., F.R.S., F.Z.S.—On some Points in the Structure of the Lesser Anteater (*Tamandua tetradactyla*), with a note on the Cerebral Arteries of *Myrmecophaga*.

2. Dr. W. T. CALMAN, F.Z.S.—On Decapod Crustacea from Christmas Island, collected by Dr. C. W. Andrews, F.R.S., F.Z.S.

3. P. CHALMERS MITCHELL, M.A., D.Sc., LL.D., F.R.S.,  
Sec.Z.S.—Notes on a Young Specimen of the Walrus lately  
living in the Society's Gardens.

4. R. H. BURNE, M.A., F.Z.S.—Notes on the Viscera of a  
Walrus (*Trichechus rosmarus*).

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The following communication has been received:—

G. C. SHORTRIDGE.—An Account of the Geographical Dis-  
tribution of the Marsupials and Monotremes of South-west  
Australia, having special reference to the specimens collected  
during the Balston Expedition of 1904–1907.

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Communications intended for the Scientific Meetings of the  
ZOOLOGICAL SOCIETY OF LONDON should be addressed to

P. CHALMERS MITCHELL,

*Secretary.*

3 HANOVER SQUARE, LONDON, W.

*June 1st, 1909.*





ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

June 15th, 1909.

Dr. A. SMITH WOODWARD, F.R.S., Vice-President,  
in the Chair.

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Mr. H. W. UNTHANK, F.Z.S., exhibited a skull of *Sphenodon* with two bones on each side in the nasal region, and made the following remarks:—"In place of the usual single nasal on each side there appear to be two bones, one near the median line, the other more external, the line of division running from before backwards. On sawing across the middle of the nasal region the anterior part of the median pair of bones came away with the premaxillæ and vomers, leaving the external bones *in situ*. These show bevelled inner edges where they were slightly overlapped by the median bones, so that the surface-marking is that of a suture in the middle of what is usually a single nasal bone."

The SECRETARY exhibited the ears of an Elephant shot by Mr. Sutton Timmis, F.Z.S., on the Guaso Ngishu Plateau, east of Mt. Elgon, B. E. Africa.

Mr. J. C. WHITE, C.I.E., C.M.Z.S., exhibited photographs of a young living specimen of a Takin (*Budorcas taxicolor whitei*) from Ghassa, N.W. Bhutan. The photographs had been taken on board ship at Calcutta and the animal was to be presented to the Society. The Secretary added that he had ascertained that the Takin had reached Genoa in good condition and might be expected at the Gardens about June 21st. It was the first Takin that had reached Europe alive.

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On behalf of Mr. R. LYDEKKER, the SECRETARY exhibited photographs of a spotted bull Tsaine or Bantin, shot by Mr. Arthur Porter in the great forest of Siam in November 1908, which Mr. Lydekker proposed provisionally to name *Bos sondaicus porteri*.

Mr. OLDFIELD THOMAS, F.R.S., F.Z.S., exhibited specimens of a new Rat which had been obtained by Mr. G. C. Shortridge during the Society's collecting expedition to Central America. It was distinguished as follows:—

OTOTYLOMYS GUATEMALÆ, sp. n.

Considerably larger than *O. phyllotis*, greyer in colour, and with the feet parti-coloured, as in some species of *Tylomys*.

Head and body 170 mm.; tail 161; hind foot 28; skull 40·7.

*Hab.* Tucuru, Guatemala. *Type.* B. M. No. 9.6.11.13.

Dr. F. WOOD JONES, F.Z.S., gave a demonstration, illustrated by specimens, models, and lantern-slides, of the method of formation of coral islands and reefs.

The purpose of the demonstration was to show that the theories of subsidence put forward by Darwin, and of solution put forward by Sir John Murray, were both untenable in the light of actual facts to be observed on coral islands.

A fresh hypothesis—that sedimentation is the most important factor—was substituted for these theories; and it was pointed out that the atoll was in reality a structure analogous to the Porites colonies the upper surfaces of which were made basin-shaped by sediment obliterating the zooids of their central area.

That the deposition of sediment below the “limiting line of sedimentation” probably accounted for the bathymetrical limit of the reef-building corals, and for the formation of sedimentation banks up to that line.

That in the making of the atoll from the basin-shaped reef the winds and the waves played the greatest part, and that atoll lagoons tended to shoal owing to the deposition of sediment within them.

That Le Conte in 1856 had said that barrier reefs stood out from shore because they were limited on one side by the depth and on the other by the muddiness of the water, and that his pronouncement accorded with every known fact.

That the question of the formation of coral structures was a zoological one and was to be solved by a study of the living zooid and that the chief agent inimical to the growth of the zooid was the deposition of sediment.

Dr. R. BROOM, C.M.Z.S., exhibited an unborn fœtus of *Chrysochloris hottentota* and two young specimens of *C. asiatica*, one probably only a couple of days old, and made some remarks on the habits and life-history of the Cape Moles. Dr. Broom also exhibited the skulls of two South African fossil reptiles, *Lycosuchus vanderrieti* and *Bauria cynops*, the former being the most perfect Therocephalian skull yet discovered.

Dr. R. BROOM, C.M.Z.S., presented a paper "On the Organ of Jacobson in *Orycteropus*."

*Orycteropus* has a long narrow organ of Jacobson which opens into the naso-palatine canal. The arrangement of the cartilages is quite different from the type found in the higher Eutheria, and there is also a marked difference from the arrangement in *Dasypus*. The general structure comes nearest to that of the Marsupials, though there are a number of striking differences.

Mr. F. E. BEDDARD, M.A., F.R.S., F.Z.S., communicated a paper entitled "On some Points in the Structure of the Lesser Anteater (*Tamandua tetradactyla*), with a note on the Cerebral Arteries of *Myrmecophaga*."

Dr. W. T. CALMAN, F.Z.S., presented a paper "On Decapod Crustacea from Christmas Island, collected by Dr. C. W. Andrews, F.R.S., F.Z.S."

A paper was received from Mr. H. L. HAWKINS, communicated by Dr. F. A. BATHER, F.R.S., F.Z.S., on "An Abnormal Individual of the Echinoid *Amblypneustes*."

Mr. STANLEY KEMP, B.A., presented a paper, communicated by Dr. W. T. CALMAN, F.Z.S., entitled "The Decapods of the Genus *Gennadas* collected by H.M.S. 'Challenger.'"

The Secretary, Dr. P. CHALMERS MITCHELL, F.R.S., presented a paper entitled "Notes on a Young Walrus (*Odobenus rosmarus*) recently living in the Society's Gardens," and exhibited a sketch made from the living animal by Mr. Carton Moore-Park, F.Z.S.

A paper was received from Mr. R. H. BURNE, M.A., F.Z.S., entitled "Notes on the Viscera of a Walrus (*Odobenus rosmarus*)."

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This Meeting closes the Session 1908-1909. The next Session (1909-1910) will begin in November next.

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The following Papers have been received :—

1. G. C. SHORTRIDGE.—An Account of the Geographical Distribution of the Marsupials and Monotremes of South-west Australia, having special reference to the specimens collected during the Balston Expedition of 1904–1907.

2. Sir HENRY H. HOWORTH, K.C.I.F., D.C.L., F.R.S., F.Z.S.—Some living Shells, their Recent History, and the light they throw on the latest Physical Changes in the Earth.

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Communications intended for the Scientific Meetings of the ZOOLOGICAL SOCIETY OF LONDON should be addressed to

P. CHALMERS MITCHELL,  
*Secretary.*

3 HANOVER SQUARE, LONDON, W.  
*June 22nd, 1909.*



ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

November 9th, 1909.

S. F. HARMER, Esq., M.A., F.R.S., Vice-President, in the Chair.

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The SECRETARY read a report on the additions that had been made to the Society's Menagerie during the months of May, June, July, August, and September, 1909.

The SECRETARY exhibited the frontlet of a Mishmi Takin (*Budorcas taxicolor*) obtained in 1903 in N.E. Saikwa, Upper Assam, and lent by Mr. J. D. Berrington, of Abergavenny.

The SECRETARY also exhibited a carved figure of a Takin, made by a Khamti who had shot the animal. The figure had been presented to the Society by Mrs. Brian Hodgson, and was referred to in the late Mr. B. H. Hodgson's original description of the Takin.

Prof. E. A. MINCHIN, V.P.Z.S., exhibited two specimens of a *Cysticercus*-stage of a Tapeworm found by him in the body-cavity of the Rat-Flea (*Ceratophyllus fasciatus*).

Dr. R. T. LEIPER, F.Z.S., exhibited specimens of some rare Helminths of Man, including a new Nematode Worm found in abscesses in natives of Trinidad, viz. :—

LAGOCHILASCARIS MINOR, sp. n.

An Ascarid with three jaws split along their inner surfaces and separated from body by a deep furrow. Small cuticular labia intermedia. Narrow keel of cuticle projecting from body in

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region of lateral bands. Œsophagus simple. Male 9 mm. in length, with over 24 pairs of præanal and with 5 pairs of post-anal papillæ. Spicules solid at tips, sickle-shaped, measuring 0.35 mm. and 0.4 mm. in length. Female 15 mm. long. Vulva 6 mm. from mouth. Ova round, with thick and pitted shell.—Types in London School of Tropical Medicine.

Dr. A. SMITH WOODWARD, F.R.S., V.P.Z.S., on behalf of Mr. R. LYDEKKER, exhibited an old coloured print of the chief room of Bullock's Museum (1809–1819) in the building subsequently known as the Egyptian Hall.

A paper was read by Sir HENRY H. HOWORTH, D.C.L., F.R.S., Z.S., on "Some Living Shells, their Recent Biology, and the Light they throw on the Latest Physical Changes in the Earth.—I. *MYA ARENARIA*." He stated that the *Mya arenaria* or Clam is widely distributed in the North Boreal, European, and North-American seas, and claimed to prove that it is a recent migrant into the former, and has probably not been there more than 300 years. The notion that it is an Arctic shell is a mistake. In the Arctic lists *Mya truncata* var. *oblonga* has been mistaken for it, and the glacial character of the beds in which it has occurred, which has been postulated from its occurrence there, has accordingly been a wrong inference. Brögger has argued that it migrated from America. It was abundant in the Crag seas, and occurs in derivative fragments in the Drift-beds, but it does not occur in the estuarine deposits or raised beaches, proving that after the period of the Crag it became extinct in Europe and has since been re-introduced. He regarded the cause of its extinction as a mystery, since the group of estuarine shells with which it is found has lived continuously in Europe since later Crag times.

Mr. C. TATE REGAN, M.A., F.Z.S., read a paper on the Asiatic Fishes of the family Anabantidæ (including the Osphromenidæ). He remarked that the order Labyrinthici was an isolated and terminal group, probably derived from a Cyprinodontoid stock, and that it comprised two suborders, Ophiocephaloidei and Anabantoidei, the latter including the families Anabantidæ and Luciocephalidæ. The Indian element in the freshwater fish-fauna of Celebes, including two Labyrinthic fishes, was shown to consist of (1) species which had travelled by sea, and (2) species which had probably been introduced by man. The great importance of Wallace's Line for freshwater fishes was thus vindicated. The Asiatic genera and species of Anabantidæ were described, including several new forms of *Betta* and *Trichopodus*, and the Asiatic genus *Anabas* was shown to differ markedly from the African *Ctenopoma* and *Spirobranchus*.

Mr. J. LEWIS BONHOTE, M.A., F.Z.S. communicated a paper on some Mammals brought home from Egypt. The paper dealt

with about twenty-eight species, chiefly small rodents, and the main points of interest were the recognition of *Procavia burtoni*, the Egyptian Hyrax, as a valid species, the rediscovery of *Acomys russatus*, hitherto only known from Palestine, and the description of a small species of *Dipodillus*; the last two species having been taken on the Mokattam Hills within three miles of Cairo.

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The next Meeting of the Society for Scientific Business will be held on Tuesday, the 23rd November, 1909, at half-past Eight o'clock P.M., when the following communications will be made:—

Exhibition of Lantern-slides illustrating the Haunts and Habits of Our British Nesting Terns. By WILLIAM BICKERTON, F.Z.S., M.B.O.U.

1. G. C. SHORTRIDGE.

An Account of the Geographical Distribution of the Marsupials and Monotremes of South-west Australia, having special reference to the specimens collected during the Balston Expedition of 1904-1907.

2. Mrs. E. W. SEXTON.

Notes on some Amphipoda from the North Side of the Bay of Biscay: Families PLEUSTIDÆ and EUSIRIDÆ.

3. R. LYDEKKER.

Note on *Sotalia borneënsis*.

4. Col. J. M. FAWCETT.

(a) On two remarkable Instances of Aberration in NYMPHALINÆ from the Andaman Islands.

(b) Aberrations of *Papilio clytia*, race PANOPE.

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The following communications have been received:—

1. Dr. F. D. WELCH, F.Z.S.

(a) On change of Colour in a Specimen of *Mellivora ratel* living in the Society's Gardens.

(b) A comparative Examination of three living Specimens of *Felis tigris sondaica*, with Notes on an old Javan male.

2. W. E. AGAR, M.A., D.Sc.

The Nesting-habits of *Phyllomedusa sauvagii*.

3. Miss RUTH M. HARRISON and Miss MARGARET POOLE.

(a) Marine Fauna from the Mergui Archipelago, Lower Burma, collected by Jas. J. Simpson, M.A., B.Sc., and R. N. Rudmose-Brown, B.Sc., University of Aberdeen : MADREPORARIA.

(b) Marine Fauna from the Kerimba Archipelago, Portuguese East Africa, collected by Jas. J. Simpson, M.A., B.Sc., and R. N. Rudmose-Brown, B.Sc., University of Aberdeen : MADREPORARIA.

4. F. E. BEDDARD, M.A., F.R.S., F.Z.S.

(a) Some Notes upon *Boa occidentalis* and *Boa (Pelophilus) madagascariensis*.

(b) Notes upon the Anatomy of *Pithecia pithecia*.

5. G. A. BOULENGER, F.R.S., V.P.Z.S.

On the Ophidian genus *Grayia*.

6. The Hon. PAUL A. METHUEN.

On a Collection of Fresh-water Crustacea from the Transvaal.

7. J. T. CUNNINGHAM, M.A., F.Z.S.

On the Marine Fishes and Invertebrates of St. Helena.

8. S. A. NEAVE, M.A., B.Sc., M.B.O.U.

Zoological Collections from Northern Rhodesia and adjacent Territories : LEPIDOPTERA RHOPALOCERA.

Communications intended for the Scientific Meetings of the ZOOLOGICAL SOCIETY OF LONDON should be addressed to

P. CHALMERS MITCHELL,

*Secretary.*

3 HANOVER SQUARE, LONDON, W.

November 16th, 1909.



ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

November 23rd, 1909.

Dr. A. SMITH WOODWARD, F.R.S., Vice-President, in the Chair.

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The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY read a report on the additions that had been made to the Society's Menagerie during the month of October 1909.

The SECRETARY read a letter from Prof. WILLIAM RIDGEWAY, M.A., D.Sc., correcting an error which had occurred in his paper on "The Differentiation of the Three Species of Zebras" (P. Z. S. 1909, p. 556). He had suggested that the type specimen of Ward's Zebra was the skin of an animal shot by Lord Delamere near Baringo, but he was now informed by Messrs. Rowland Ward that the specimen had been purchased in the flesh from Barnum and Bailey's Menagerie.

Dr. F. D. WELCH, F.Z.S., exhibited photographs of a male Gayal (*Bibos frontalis*) living in the Society's Gardens, in which the lower halves of both fore and hind legs were almost entirely black instead of pure white as in the normal adult.

Mr. WILLIAM BICKERTON, F.Z.S., M.B.O.U., exhibited a very remarkable series of lantern-slides illustrating the Nesting Haunts and Habits of the five species of British Nesting Terns, of which he had made a special photographic study. Some of the slides showed the fully expanded wings of the birds when alighting after

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\* This Abstract is published by the Society at 3 Hanover Square, London, W., on the Tuesday following the date of Meeting to which it refers. It will be issued, free of extra charge, to all Fellows who subscribe to the Publications, along with the 'Proceedings'; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

flight, and the pictures of the Roseate Terns were of special interest, being the only series ever taken of this species within the British Isles.

A paper was received from Mr. G. C. SHORTRIDGE, communicated by Mr. OLDFIELD THOMAS, F.R.S., F.Z.S., entitled "An Account of the Geographical Distribution of the Marsupials and Monotremes of South-west Australia, having special reference to the specimens collected during the Balston Expedition of 1904-1907."

Dr. W. T. CALMAN, F.Z.S., communicated a paper by Mrs. E. W. SEXTON, entitled "Notes on some Amphipoda from the North Side of the Bay of Biscay."

The paper contained notes on the development of the females of certain Amphipoda, showing that structural modification continues even after sexual maturity is reached, and this may give rise to differences of so striking a character that earlier and later stages might easily be mistaken for distinct species. This was illustrated by examples from the families PLEUSTIDÆ and EUSIRIDÆ.

The SECRETARY communicated a paper by Lt.-Col. J. M. FAWCETT on "Aberrations in NYMPHALINÆ from the Andaman Islands, and of *Papilio clytia* from Burma."

Mr. R. LYDEKKER presented a "Note on the Cetacean *Sotalia borneensis*," which contained a correction of his description of this species published in the Society's 'Proceedings' for 1901 (p. 88, pl. viii.).

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The next Meeting of the Society for Scientific Business will be held on Tuesday, the 14th December, 1909, at half-past Eight o'clock P.M., when the following communications will be made :—

1. Dr. F. D. WELCH, F.Z.S.

(a) On change of Colour in a Specimen of *Mellivora ratel* living in the Society's Gardens.

(b) A comparative Examination of three living Specimens of *Felis tigris sondaica*, with Notes on an old Javan male.

2. W. E. AGAR, M.A., D.Sc.

The Nesting-habits of *Phyllomedusa sauravii*.

3. Miss RUTH M. HARRISON and Miss MARGARET POOLE.

(a) Marine Fauna from the Mergui Archipelago, Lower Burma, collected by Jas. J. Simpson, M.A., B.Sc., and R. N. Rudmose-Brown, B.Sc., University of Aberdeen : MADREPORARIA.

(b) Marine Fauna from the Kerimba Archipelago, Portuguese East Africa, collected by Jas. J. Simpson, M.A., B.Sc., and R. N. Rudmose-Brown, B.Sc., University of Aberdeen : MADREPORARIA.

4. F. E. BEDDARD, M.A., F.R.S., F.Z.S.

(a) Some Notes upon *Boa occidentalis* and *Boa (Pelophilus) madagascariensis*.

(b) Notes upon the Anatomy of Monkeys of the Genus *Pithecia*.

5. G. A. BOULENGER, F.R.S., V.P.Z.S.

On the Ophidian Genus *Grayia*.

The following communications have been received :—

1. The Hon. PAUL A. METHUEN.

On a Collection of Fresh-water Crustacea from the Transvaal.

2. J. T. CUNNINGHAM, M.A., F.Z.S.

On the Marine Fishes and Invertebrates of St. Helena.

3. S. A. NEAVE, M.A., B.Sc., F.Z.S.

Zoological Collections from Northern Rhodesia and adjacent Territories: LEPIDOPTERA RHOPALOCERA.

4. W. M. SMALLWOOD.

Notes on the Hydroids and Nudibranchs of Bermuda.

5. Dr. W. T. CALMAN, F.Z.S.

On new or rare Crustacea of the Order Cumacea from the Collection of the Copenhagen Museum.—Pt. II. The Families NANNASTACIDÆ and DIASTYLIDÆ.

Communications intended for the Scientific Meetings of the ZOOLOGICAL SOCIETY OF LONDON should be addressed to

P. CHALMERS MITCHELL,

*Secretary.*

3 HANOVER SQUARE, LONDON, W.

*November 30th, 1909.*



ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

December 14th, 1909.

G. A. BOULENGER, Esq., F.R.S., Vice-President, in the Chair.

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The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY read a report on the additions that had been made to the Society's Menagerie during the month of November 1909.

Mrs. R. HAIG THOMAS, F.Z.S., exhibited seven skins of Hybrid Pheasants, and remarked on the evidence they seemed to afford of the transmission of female characters by the male.

Mr. D. SETH-SMITH, F.Z.S., the Society's Curator of Birds, exhibited a photograph of a nest built by a pair of Tufted Umbres (*Scopus umbretta*) in the Great Flying Aviary at the Gardens. The nest is composed of sticks, cemented together with mud, and measures about four feet in diameter and three feet in height. The interior consists of a single chamber nearly two feet in diameter, with an entrance-hole five inches wide. No eggs have been laid by these birds, although they have frequently paired.

Dr. H. B. FANTHAM, F.Z.S., Protozoologist to the Grouse Commission, exhibited microscopic preparations and sketches illustrating the life-cycle of the Sporozoon *Eimeria tenellum* (*Coccidium avium*), parasitic in the alimentary canal of Grouse. The parasite produces a fatal coccidiosis in Grouse chicks, especially during the first month or six weeks of their life. Schizogony and

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sporogony occur in both the duodenum and the cæcum of the host. The cæca of Grouse chicks dying from coccidiosis are full of spores (oöcysts), which are passed out with the cæcal droppings, forming a source of infection on the moors. On the ingestion of the spores by other Grouse, the sporozoites are liberated by the action of the pancreatic juice. Larvæ of *Scatophaga*, found in Grouse-droppings, swallow the Coccidian spores, voiding them uninjured, and so aiding in the dissemination of the spores in nature.

The coccidiosis of Grouse is transmissible directly to young fowls and young pigeons by feeding these birds on fæces of infected Grouse.

Dr. C. W. ANDREWS, F.R.S., F.Z.S., exhibited and made remarks upon a photograph showing some Robber-Crabs (*Birgus latro*) climbing the trunk of the Christmas Island Sago-palm (*Arenga listeri*). He also made some observations on the habits and food of these Crustaceans.

Dr. R. T. LEIPER, F.Z.S., exhibited the original specimens of the nematode worm *Acanthocheilonema dracunculoides* Cobb., from the Museum of the Royal College of Surgeons. The characters of the genus, of which this is the type, are found to have been inaccurately interpreted, the posterior end of the worm having been described as the head and the cuticular caudal appendages regarded as "lips." The remarkable specific characters—viz., the entire absence of male forms and the lack in the female of vaginal opening—had also to be repudiated, for both are to be seen in the original material. The genus, as revised, would admit a second species, the *Filaria perstans* of Man.

Dr. F. D. WELCH, F.Z.S., read two papers entitled: (a) "On change of Colour in a Specimen of *Mellivora ratel* living in the Society's Gardens," and (b) "A comparative Examination of three living Specimens of *Felis tigris sondaica*, with Notes on an old Javan male."

Mr. G. A. BOULENGER, F.R.S., V.P.Z.S., communicated a paper by Dr. W. E. AGAR, M.A., on "The Nesting-Habits of the Tree-Frog, *Phyllomedusa sauvagii*." This Frog makes a nest suspended from bushes overhanging a pool, into which the tadpoles drop when they are hatched. The nest is constructed from a number of leaves, the lower ends of which are drawn together and held so by a deposit of empty gelatinous egg-capsules, forming together a thick jelly. After oviposition the nest is closed with a similar mass of empty capsules, so that in a well made nest not a single egg is exposed to the light and air.

Miss RUTH M. HARRISON and Miss MARGARET POOLE jointly presented two papers, communicated by Prof. G. C. BOURNE, D.Sc., F.Z.S., on Madreporaria collected by Jas. J. Simpson, M.A., B.Sc., and R. N. Rudmose-Brown, B.Sc., University of Aberdeen, from the Mergui Archipelago, Lower Burma, and from the Kerimba Archipelago, Portuguese East Africa.

Mr. F. E. BEDDARD, M.A., F.R.S., F.Z.S., Prosector to the Society, presented two papers entitled: (a) "Some Notes upon *Boa occidentalis* and *Boa (Pelophilus) madagascariensis*"; (b) "Notes upon the Anatomy of Monkeys of the Genus *Pithecia*."

Mr. G. A. BOULENGER, F.R.S., V.P.Z.S., read a paper "On the Ophidian Genus *Grazia*," in which he contributed to the revision of the genus made necessary by an increased knowledge of African Snakes.

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The next Meeting of the Society for Scientific Business will be held on Tuesday, the 18th January, 1910, at half-past Eight o'clock P.M., when the following communications will be made:—

1. Dr. H. G. PLIMMER, F.L.S., F.Z.S., Pathologist to the Society  
Report on Pathological Observations at the Society's Gardens during 1909.
  2. S. A. NEAVE, M.A., B.Sc., F.Z.S.  
Zoological Collections from Northern Rhodesia and adjacent Territories: LEPIDOPTERA RHOPALOCERA.
  3. J. T. CUNNINGHAM, M.A., F.Z.S.  
On the Marine Fishes and Invertebrates of St. Helena.
  4. W. M. SMALLWOOD.  
Notes on the Hydroids and Nudibranchs of Bermuda.
  5. Dr. W. T. CALMAN, F.Z.S.  
On new or rare Crustacea of the Order Cumacea from the Collection of the Copenhagen Museum.—Pt. II. The Families NANNASTACIDÆ and DIASTYLIDÆ.
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The following communications have been received:—

1. The Hon. PAUL A. METHUEN.

On a Collection of Fresh-water Crustacea from the Transvaal.

2. Dr. JOSEPH PEARSON, F.L.S.

(a) Littoral Marine Fauna: Kerimba Archipelago, Portuguese East Africa, collected by Jas. J. Simpson, M.A., B.Sc., University of Aberdeen. Sept. 1907 to May 1908. HOLOTHURIOIDEA.

(b) Marine Fauna: Mergui Archipelago, Lower Burma, collected by Jas. J. Simpson, M.A., B.Sc., and R. N. Rudmose-Brown, B.Sc., University of Aberdeen: HOLOTHURIOIDEA.

3. ROWLAND E. TURNER, F.Z.S., F.E.S.

Additions to our Knowledge of the Fossorial Wasps of Australia.

4. T. MANNERS-SMITH, M.A., M.B.

The Limb Arteries of Primates.

5. Dr. G. STEWARDSON BRADY, LL.D., D.Sc., F.R.S., C.M.Z.S.

A Revision of the British Species of Ostracoda belonging to the Subfamilies CANDONINÆ and HERPETOCYPHRIDINÆ.

6. HAMILTON H. DRUCE, F.L.S., F.Z.S.

Descriptions of new LYCÆNIDÆ and HESPERIIDÆ from Tropical West Africa.

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Communications intended for the Scientific Meetings of the ZOOLOGICAL SOCIETY OF LONDON should be addressed to

P. CHALMERS MITCHELL,

*Secretary.*

3 HANOVER SQUARE, LONDON, W.

*December 21st, 1909.*



# THE ZOOLOGICAL SOCIETY OF LONDON.

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THIS Society was founded in 1826 by Sir STAMFORD RAFFLES, Mr. J. SABINE, Mr. N. A. VIGORS, and other eminent Naturalists, for the advancement of Zoology and Animal Physiology, and for the introduction of new and curious subjects of the Animal Kingdom, and was incorporated by Royal Charter in 1829.

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## COUNCIL.

HIS GRACE THE DUKE OF BEDFORD, K.G., *President.*

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PROF. JOHN ROSE BRADFORD, M.D., D.Sc., F.R.S., <i>Vice- President.</i>	SIR EDMUND G. LODER, Bt. E. G. B. MEADE-WALDO, Esq.
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FREDERICK GILLET, Esq.	OLDFIELD THOMAS, Esq., F.R.S.
F. DUCANE GODMAN, Esq., D.C.L., F.R.S., <i>Vice-President.</i>	AUBYN TREVOR-BATTYE, Esq., M.A.
THE MARQUIS OF HAMILTON, M.P.	A. SMITH WOODWARD, Esq., LL.D., F.R.S., <i>Vice-President.</i>
	HENRY WOODWARD, Esq., LL.D., F.R.S.

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The Society consists of Fellows, and Honorary, Foreign, and Corresponding Members, elected according to the By-Laws. It carries out the objects of its foundation by means of the collection of living animals at Regent's Park, by its Library at 3, Hanover Square, W., and by its scientific publications.

The Office of the Society (3, Hanover Square), where all communications should be sent, addressed to "The Secretary," is open from Ten till Five, except on Saturdays, when it closes at Two P.M.

The Library, under the superintendence of Mr. F. H. Waterhouse, is open daily at the above hours.

The Meetings of the Society for General Business are held at the Office on the third Wednesday in every month of the year, except in September and October, at Five P.M.

The Meetings for Scientific Business are held at the Office twice a month on Tuesdays, except in July, August, September, and October, at half-past Eight o'clock P.M.

The Anniversary Meeting is held on the 29th. of April, or the nearest convenient day, at Four P.M.

The Gardens in the Regent's Park are open daily from Nine o'clock until Sunset. Mr. R. I. Pocock, F.L.S., is the resident Superintendent and Curator of Mammals and Reptiles. Mr. D. Seth-Smith is Curator of Birds and Inspector of Works. The Prosectorium for Anatomical and Pathological work at the Gardens is under the charge of Mr. Frank E. Beddard, M.A., F.R.S., Prosector, assisted by Mr. H. G. Plimmer, M.R.C.S., Pathologist to the Society.

#### TERMS FOR THE ADMISSION OF FELLOWS.

FELLOWS pay an Admission Fee of £5, and an annual Contribution of £3, due on the 1st. of January, and payable in advance, or a Composition of £45 in lieu thereof; the whole payment, including the Admission Fee, being £50.

No person can become a FELLOW until the Admission Fee and First Annual Subscription have been paid, or the annual payments have been compounded for.

FELLOWS elected after the 31st. of August are not liable for the Subscription for the year in which they are elected.

## PRIVILEGES OF FELLOWS.

FELLOWS have Personal Admission to the Gardens with Two Companions daily, upon signing their names in the book at the entrance gate.

The WIFE or HUSBAND of a FELLOW can exercise these privileges in the absence of the Fellow.

Every FELLOW is entitled to receive annually 60 undated Green Cards, and, when no specific instructions are received, the supply will be sent in this form. If preferred, however, 20 Green Cards may be exchanged for a book containing 2 Orders for each Saturday\* throughout the year. A similar book of Sunday Orders may also be obtained in lieu of 20 Green Cards. A Green Card may also be exchanged for 2 Buff Cards for the use of Children under 12 years of age.

It is particularly requested that Fellows *will sign every Ticket* before it goes out of their possession. Unsigned Tickets are not available.

Green and Buff Tickets may be used on any day and in any year, but in no case can two Children be admitted with one Adult Ticket, or an Adult be admitted with two Children's Tickets.

The annual supply of Tickets will be sent to each FELLOW on the 1st. of January in every year, upon filling up and returning the form of Standing Order supplied to Fellows.

FELLOWS are not allowed to pass in friends on their written Order or on presentation of their Visiting Cards.

FELLOWS are exempt from payment of the fee for Painting, Sketching, and Photographing in the Society's Gardens.

FELLOWS have the privilege of receiving the Society's ordinary Publications issued during the year upon payment of the additional Subscription of One Guinea. This Subscription is due upon the 1st. of January, and must be paid before the day of the Anniversary Meeting, after which the privilege lapses. FELLOWS are likewise entitled to purchase these Publications at 25 per cent. less than the price charged to the public. A further reduction of 25 per cent. is also made upon all purchases of Publications issued prior to 1881, if above the value of Five Pounds.

FELLOWS also have the privilege of subscribing to the Annual Volume of 'The Zoological Record,' which gives a list of the Works and Publications relating to Zoology in each year, for the sum of

\* The Saturday Orders are not available if the Fellow introduces friends personally on that day.

One Pound Ten Shillings. Separate divisions of volumes 39 to 42 can also be supplied. Full particulars of these publications can be had on application to the Secretary.

FELLOWS may obtain a TRANSFERABLE IVORY TICKET admitting two persons, available throughout the whole period of Fellowship, on payment of Ten Pounds in one sum. A second similar ticket may be obtained on payment of a further sum of Twenty Pounds.

Any FELLOW who intends to be absent from the United Kingdom during the space of one year or more, may, upon giving to the Secretary notice in *writing*, have his or her name placed upon the "dormant list," and will be thereupon exempt from the payment of the annual contribution during such absence.

Any FELLOW, having paid all fees due to the Society, is at liberty to withdraw his or her name upon giving notice in *writing* to the Secretary.

Ladies or Gentlemen wishing to become Fellows of the Society are requested to communicate with the undersigned.

P. CHALMERS MITCHELL,

*Secretary.*

3 Hanover Square, London, W.,  
April 1st, 1910.

MEETINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON  
FOR  
SCIENTIFIC BUSINESS.  
(AT 3 HANOVER SQUARE, W.)

1910.

TUESDAY, APRIL	5 & 19
" MAY	3 & 24
" JUNE	14
" NOVEMBER	15 & 29
" DECEMBER	13

*The Chair will be taken at half-past Eight o'clock in the Evening  
precisely.*



# ZOOLOGICAL SOCIETY OF LONDON.

## THE ZOOLOGICAL RECORD.

THE object of the ZOOLOGICAL RECORD is to give, by means of an annual Volume, complete lists of the Works and Publications relating to Zoology in all its branches that have appeared during the year preceding the issue of the Volume, together with full information as to the points they deal with, arranged in such a manner as to serve as an Index to the literature of Zoology in all parts of the globe, and thus to form a repertory that will retain its value for the Student in future years.

The 'Zoological Record' having been amalgamated with the International Catalogue of Scientific Literature, Zoology, Volumes from 43 onwards can now be obtained only from Messrs. Harrison & Sons, except when purchasing complete sets from the Zoological Society.

Under the scheme of amalgamation, Fellows of the Society, and Institutions already on the subscription-list, have the privilege of subscribing at the old rate of 30s. per annum, which covers the cost of carriage of the volume. The subscription becomes due on July 1st in each year, and lapses if not paid by the 1st of December following.

The Society is able to supply complete sets of the Record on the following terms :—

Vols. 1 to 37, Price £14 10s. net.

Vols. 38, 39, and 40 at 10s. net.

Vol. 41 and onwards at 40s. each.

The prices for *separate* volumes are as follows :—

Vols. 1 to 40 (except Vols. 4 and 6) 10s. each net.

Vols. 41 and 42 at 40s. each. The price of the 'Zoological Record,'

Vol. 43 and subsequent volumes, published now by Messrs. Harrison and Co., is 40s. each.

INDEX ZOOLOGICUS. An alphabetical list of names of genera and subgenera proposed for use in Zoology, as recorded in the 'Zoological Record,' 1880–1900; together with other names not included in the 'Nomenclator Zoologicus' of S. H. Scudder. Compiled (for the Zoological Society of London) by CHARLES OWEN WATERHOUSE and edited by DAVID SHARP, Editor of the 'Zoological Record.' London, 1902. Price to Fellows, 18s.; price to the public, 20s., or if sold with a set, 10s.

Divisions of the 'Zoological Record' of Vols. 39 to 42 can be supplied by the Society, but *after* Vol. 42 they can be had only of Messrs. Harrison & Sons, 46 St. Martin's Lane, W.C.

## SEPARATE DIVISIONS OF THE ZOOLOGICAL RECORD.

Divisions of the 'Zoological Record,' Vols. 39-42, containing the literature of the years 1902-1905, may be obtained separately as follows:—

	s.	d.
List of abbreviations of journals, etc. . . . .	2	0 net.
Special Records, viz. :—		
I. General Subjects . . . . .	2	6 „
II. Mammalia . . . . .	2	6 „
III. Aves . . . . .	6	0 „
IV. Reptilia and Batrachia . . . . .	2	6 „
V. Pisces . . . . .	2	6 „
VI. Tunicata . . . . .	1	0 „
VII. Mollusca . . . . .	4	0 „
VIII. Brachiopoda . . . . .	1	0 „
IX. Bryozoa . . . . .	1	0 „
X. Crustacea . . . . .	2	6 „
XI. Arachnida . . . . .	2	0 „
XII. Myriopoda . . . . .	1	6 „
XIII. Insecta . . . . .	12	0 „
XIV. Echinoderma . . . . .	3	6 „
XV. Vermes . . . . .	3	0 „
XVI. Coelenterata . . . . .	1	6 „
XVII. Spongiæ . . . . .	2	0 „
XVIII. Protozoa . . . . .	2	0 „
Index of new names of genera and subgenera .	2	0 „

Divisions from Vol. 43 onwards are now supplied by Messrs. Harrison & Sons, 46 St. Martin's Lane, London, W.C.

P. CHALMERS MITCHELL,

*Secretary.*

3 HANOVER SQUARE, LONDON, W.  
April 1st, 1910.

# LIST OF THE PUBLICATIONS

## OF THE

### ZOOLOGICAL SOCIETY OF LONDON.

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THE scientific publications of the Zoological Society of London are of two kinds—"Proceedings," published in an octavo form, and "Transactions," in quarto.

According to the present arrangements, the "Proceedings" contain not only notices of all business transacted at the scientific meetings, but also all the papers read at such meetings and recommended to be published in the "Proceedings" by the Committee of Publication. A large number of coloured plates and engravings are issued in the volumes of the "Proceedings," to illustrate the new or otherwise remarkable species of animals described therein. Amongst such illustrations, figures of the new or rare species acquired in a living state for the Society's Gardens are often given.

The "Proceedings" for each year are issued in four parts, on the first of the months of June, August, October, and April, the part published in April completing the volume for the last half of the preceding year. From January 1901 they have been issued as two half-yearly volumes.

The "Transactions" contain such of the communications made to the scientific meetings of the Society as, on account of the nature of the plates required to illustrate them, are better adapted for publication in the quarto form. They are issued at irregular intervals.

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The Abstracts of the papers read at the Scientific Meetings in November and December are contained in this Part.

















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